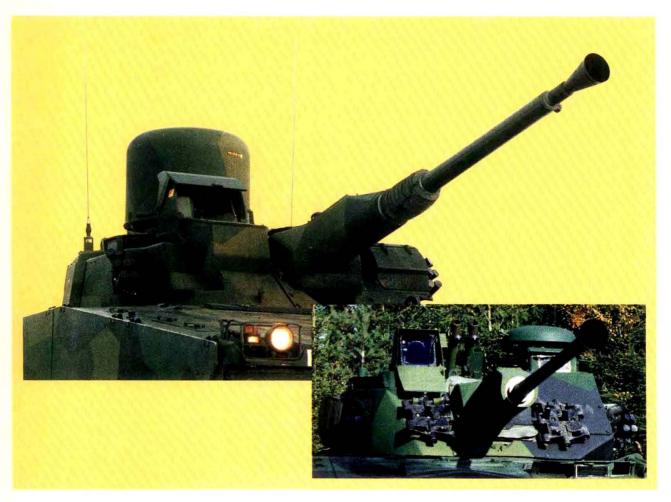
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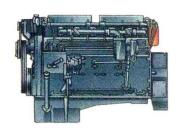


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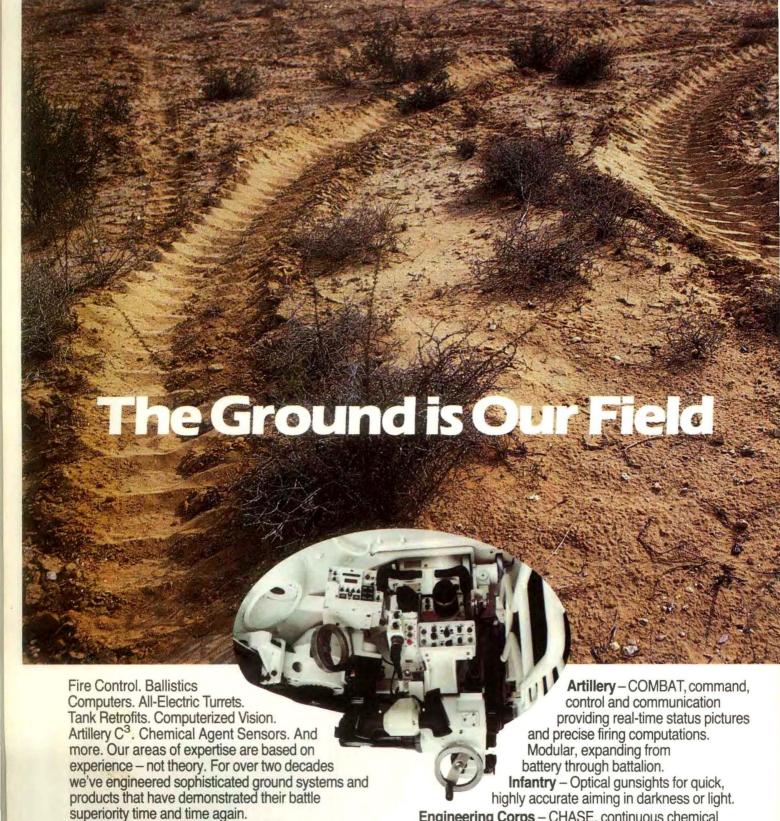
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SIXTH EDITION

EDITED BY
TONY CULLEN AND CHRISTOPHER F FOSS

1993-94

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Contents

Foreword	[15]
Abbreviations	[17]
Armoured fighting vehicle armament	
Weapons of 20 mm and upward	1
List of coaxial machine guns	48
Vehicle-mounted anti-tank guided weapons	50
Automatic loaders and flick rammers	65
Ammunition	69
Armoured fighting vehicle protection	
Armour systems	166
Smoke dischargers, grenades and decoys	186
Laser detectors	203
Fire detection and suppression	213
AFV engines, transmissions and powerpacks	220
Mobility	
Tracks	270
Suspensions	278
AFV turrets and cupolas	291
Weapon control and stabilisation systems	362
AFV fire control systems	376
Land navigation systems	412
AFV optics	
Driver day and night vision systems	436
Laser rangefinders	456
Commanders' and gunners' day and night observation and sighting systems	472
Addenda	545
Index	549

ADMINISTRATION

Publishing Director: Robert Hutchinson

Managing Editor: Keith Faulkner

Publishing Supervisor: Ruth Simmance Publishing Assistant: Elizabeth Dawson

Product Group (Marketing) Manager: Sandra Dawes

EDITORIAL OFFICES

Jane's Information Group Limited, Sentinel House, 163 Brighton Road, Coulsdon, Surrey CR5 2NH, United Kingdom

Tel: 081 763 1030 International +44 81 763 1030

Telex: 916907 Janes G

Fax: 081 763 1006 International +44 81 763 1006

SALES OFFICES

Send enquiries to:

Peter McSherry, Sales Manager, Jane's Information Group Limited, UK address as above

Send USA enquiries to:

Joe McHale, Senior Vice-President Product Sales, Jane's Information Group Inc, 1340 Braddock Place, Suite 300, Alexandria, VA 22314-1651

Tel: +1 703 683 3700 Telex: 6819193 Fax: +1 703 836 0029

ADVERTISEMENT SALES OFFICES

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Benelux: Barbara Urry, Jane's Information Group (see United

Brazil: L Bilyk, Brazmedia International S/C Ltda, Alameda Gabriel

Monteiro da Silva, 366 CEP, 01442, São Paulo

Tel: +55 11 853 4133 Telex: 32836 BMED BR Fax: +55 11 852 6485

France: Patrice Février, Jane's Information Group - France,

35 avenue Mac Mahon, F-75017 Paris, France

Tel: +33 1 45 72 3311 Fax: +33 1 45 72 1795

Germany and Austria: Rainer Vogel, Media Services International,

Schwabenbergstrasse 12, D-8089 Emmering.

Tel: +49 (8141) 42534 Fax: +49 (8141) 6706

Greece: Anwar Aswad, A&M Advertising & Marketing Consultants,

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Israel: Oreet Ben-Yaacov, Oreet International Media, 15 Kineret

Street, 51201 Bene Berak

Tel: +972 3 570 6527 Fax: +972 3 570 6526

Italy and Switzerland: Ediconsult Internazionale Srl, Piazza Fontane Marose 3, I-16123 Genoa

Tel: +39 10 583520, 583684

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Korea: Young Seoh Chinn, JES Media International, KPO Box 576,

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Spain: Jesus Moran Iglesias, Varex SA, Modesto Lafuente 4, E-28010 Madrid

Tel: +34 1 448 7622

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USA and Canada: Kimberly S. Hanson, Director of Advertising Sales

and Marketing, Jane's Information Group Inc, 1340 Braddock Place, Suite 300, Alexandria, VA 22314-1651

Tel: +1 703 683 3700 Telex: 6819193 Fax: +1 703 836 0029

USA South Eastern Region: Kristin Schulze, Regional Advertising

(see United States and Canada)

USA North Eastern Region and Canada: Melissa C Gunning,

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USA Western Region and Canada: Anne Marie St. John-Brooks, Regional Advertising Manager, Jane's Information Group, 1523

Rollins Road, Burlingame, CA 94010

Tel: (415) 259 9982 Fax: (415) 259 9751

United Kingdom/Rest of World: Barbara Urry

Jane's Information Group, Sentinel House, 163 Brighton Road,

Coulsdon, Surrey CR5 2NH

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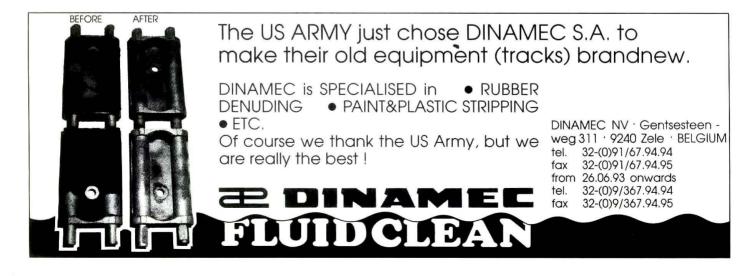
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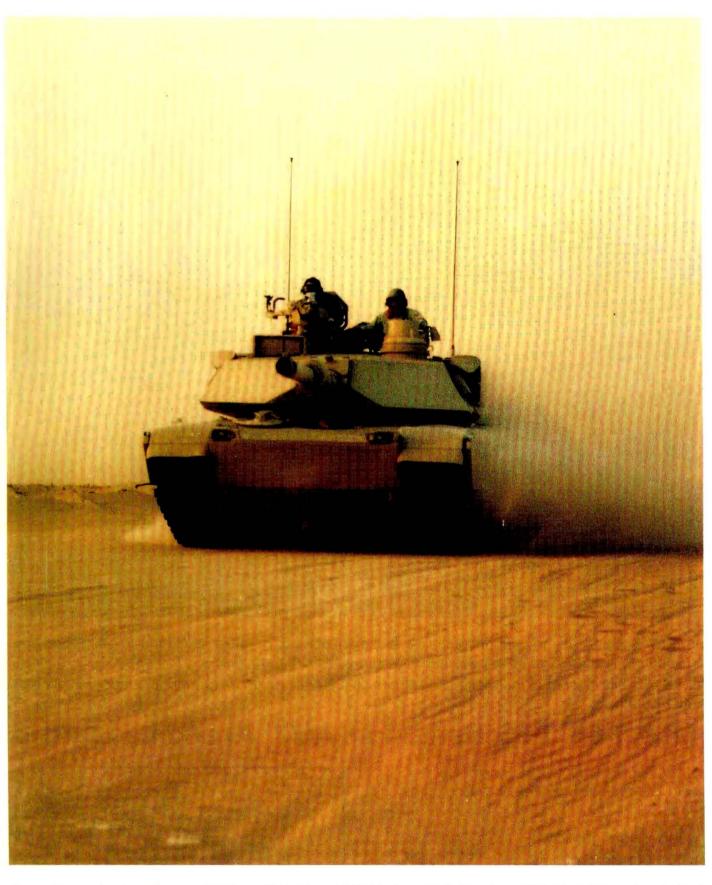
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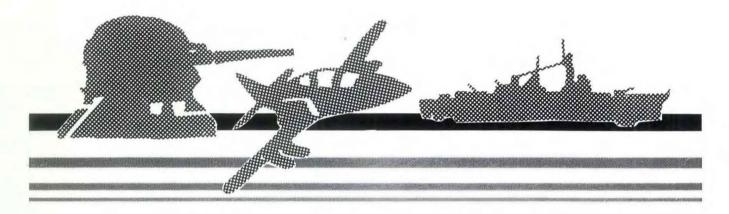
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Foreword

The time has come the politicians have said to speak of many things – the Cold War is dead, much money can be saved from military budgets and political acumen is to be had by adhering to the Peace Dividend.

Unfortunately, presented by politicians the world over to their people as the preferred world image, the truth is much more unpalatable. The Cold War has been replaced in 20th century history by what will almost certainly be called the Nineties Crisis Period – the name given to the time when uncontrollable internecine warfare and civil unrest throughout the world butchered tens of thousands of inhabitants, whilst the resolve and determination of the United Nations to end such conflicts was endlessly debated by its members in its council chambers.

In these troubled times it is the unwise who rush headlong into the dismantling of armed forces. It must be reasoned arguments and carefully thought out logic that are brought to bear on deciding just where cuts need to be made. Above all, the primary cause of the cuts should not be driven by a country's treasury as part of an effort to balance the books.

The objective these days is to have effective and well balanced armed forces that are capable of undertaking perceived operations of varying types in what is essentially an increasingly unstable world. In order to achieve satisfactory force levels it is becoming necessary for many nations to obtain new technology in the form of indigenously built or brought-in weapon systems. However, the cost involved is now so prohibitive that, in order to keep up with the perceived threat or just with their regional superpower, the next best thing is the upgrade option. This is a situation which is slowly but surely being grasped by a number of nations and which has been mastered, to such a great effect for over 25 years or so by countries such as Israel, South Africa and Sweden with, for example, their Centurion MBT fleets. A well thought out rebuild programme can produce an equally effective weapon platform as a new built item and at a much lower cost.

The United States Army has taken delivery of only 62 production versions of the General Dynamics, Land Systems Division, M1A2 Abrams MBT and has recently decided to upgrade some of its older 105 mm armed M1 MBT to the latest M1A2 standard at about two-thirds of the price of buying a new MBT. This decision will help keep the US tank industrial base intact, hopefully through the remainder of this decade.

In Germany, development work on the new MBT for the German Army has been cancelled and only a small part of the German Army fleet of 2125 Leopard 2 MBTs will now be upgraded, with the top priority being given to improved armour protection. For financial reasons, however, the Leopard 2 (Improved) will not have all of the possible battlefield enhancements that could be fitted to enable the vehicle to remain a viable weapon system into the 21st century.

Upgrading does not apply only to MBTs but also to other types of armoured vehicles including infantry fighting vehicles and even self-propelled artillery systems.

For some time the US Army has been modernising its M2 Bradley Fighting Vehicles and M3 Cavalry Fighting Vehicles with additional armour protection, more powerful engines and upgraded transmission. Significant enhancements have also been made to the 25 mm ammunition fired by the M242 McDonnell Douglas Helicopter Chain Gun to further improve its combat effectiveness.

First production examples of the M109A6 Paladin self-propelled howitzer for the US Army have been completed by BMY Combat Systems. This is essentially an upgraded M109 chassis (with the conversion being carried out by a US Army Depot) fitted with a new turret designed and built by BMY Combat Systems.

With the run down in orders for new armoured fighting vehicles and other major weapon systems, a number of manufacturers are now looking at carrying out maintenance and repair work on these vehicles which was normally carried out by army depots. In the United Kingdom, for example, the first steps towards private contractors running vehicle overhaul and upgrade facilities have already been taken.

The realistic outlook for the total system builder these days is, however, one of doom and gloom. The economic facts state that unless they have a consistent and reasonable yearly profit margin coupled with a continuing research and development programme (preferably government funded or aided) there will come a point at which the building of a total system simply becomes untenable. If the system builder cannot adjust to this situation by product diversification then a strategic asset, which is basically what the system builder is, will be lost to the host country and procurement reliance has then to be placed on external sources which, in times of tension, can turn off key support at will. This scenario has considerably more implications today than it ever had during the Cold War with the distinctive power blocks. In addition, the manufacturer also has to market the system it builds – a situation which is becoming considerably more fraught with problems for the builder as the recent Middle East MBT procurement 'battles' have shown.

One noticeable feature for this year's edition is the amount of information that is becoming available from previously closed sources. The level of sophistication of equipment from the former Soviet Union has been confirmed, with examples of CIS produced 152 mm precision guided artillery ammunition Krasnopol, anti-tank guided weapons with tandem warheads and tank protection systems being available for sale at various military exhibitions.

The extensive capabilities of the South African defence industries have also been shown widely over the past year. A number of their available AFV optics and land navigation systems are described for the first time.

Russia has recently released additional details of its 100 mm, 115 mm and 125 mm gun launched guided projectiles which have a range of 4000 to 5000 m. Traditionally, Russian tank firecontrol systems have not been so effective as their Western counterparts and for this reason Russia has spent considerable sums on the development and production of gun launched guided projectiles which have been widely deployed in the former Warsaw Pact.

Although Jane's Data Division now publishes Jane's Ammunition Handbook, Jane's Armoured Fighting Vehicle Retrofit Systems still contains a large section on armoured fighting vehicle and artillery ammunition arranged under country and manufacturer. This new edition contains much new information on Chinese, Commonwealth of Independent States and Romanian ammunition types, most of which is now being offered on the world market.

There has also been a number of developments in cannon for installation in armoured vehicles. In Sweden production of the Bofors 40 mm L/70 gun for the Swedish Army's new Combat Vehicle 90 is now underway and, in addition to the well established family of ammunition, Bofors have also developed a special Armour Piercing Fin Stabilised Discarding Sabot – Tracer Round specifically for use with the Combat Vehicle 90.

While conventional tank guns still reign supreme and development work continues on larger calibre guns and enhanced armour defeating ammunition, considerable effort is now being directed into new types of tank main armament, especially electrochemical and electrothermal guns, and these may well form the main armament of future MBTs.

At last some Western countries are paying more attention to Defensive Aid Systems (DAS) for MBTs and other armoured fighting vehicles to increase their battlefield survivability.

While new developments in armour systems of the passive and explosive reactive type continue to be made, increased emphasis on DAS for all types of AFV will be one of the trends of the future and this edition of *Jane's Armoured Fighting Vehicle Ret*rofit Systems covers many of these subsystems, including laser detectors, in some detail.

Following combat experience in the Middle East, battlefield Identification Friend or Foe (IFF) is being given increased attention, especially in the United States. This, and the incorporation of a DAS into an AFV, points the way to the systems approach in future armoured vehicles.

The incorporation of a 1553 databus in the turret of the Vickers Defence Systems Challenger 2 is a major step forward and is another pointer to the way ahead.

The replacement for the British Army Scorpion Combat Vehicle Reconnaissance (Tracked) family of vehicles is called the TRACER (Tactical Reconnaissance Armoured Combat Equipment Requirement). It will be a highly mobile vehicle which could be tracked or wheeled and fitted with a number of advanced sensors to carry out its battlefield role. For this reason, most of the prime contractor contenders for TRACER have already formed a consortium which includes team members with extensive electronics or integration capabilities.

In recent years there has been a trend away from petrol to diesel engines which are much more fuel efficient as well as being less of a fire hazard. Today, more compact diesel engines and transmissions are being developed which take up much less space than current power packs. A gas turbine powers the US M1 series of MBT and some versions of the Russian T-80 MBT, although it remains to be seen whether this is the way ahead.

Electric drive for armoured fighting vehicles has been tried before in a number of prototype vehicles or in special mission vehicles but some countries, including the United States, are now investing research and development funds to explore electric drive systems for the future. If perfected, electric drive systems offer the combat vehicle designer a number of advantages, especially if the vehicle was fitted with a new main armament of the electrothermal type.

In the past, land navigation was a major problem, not only for MBTs but also for artillery, and a number of countries are now installing a Global Positioning System (GPS) into armoured vehicles to give them a pin point accuracy.

The value of thermal night vision devices in Operation Desert Storm has led to an increasing number of countries wanting these for their armoured vehicles, especially MBTs and infantry combat vehicles. Initially, thermal observation and gunnery systems were provided for the commander and gunner only but driver thermal night vision devices have also been developed and some of the Hughes systems were deployed in the Middle East several years ago.

For ease of reference, Jane's Armoured Fighting Vehicle Retrofit Systems has been divided up into key sections: armoured fighting vehicle armament (including guns, cannon, anti-tank

guided weapons and automatic loaders); ammunition (which covers both AFV cannon, tank guns and artillery rounds); AFV protection (covering armour systems, smoke dischargers, grenades and decoys, laser detectors and fire detection and supression systems); engines, transmissions and powerpacks; mobility (including suspension and tracks); turrets and cupolas; weapon controls and stabilisation systems; fire-control systems; land navigation systems and AFV optics.

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Additional information and photographs for the seventh edition should be sent to the editors as soon as possible. The address for all correspondence is Jane's Data Division, Sentinel House, 163 Brighton Road, Coulsdon, Surrey CR5 2NH, UK. Telephone (+44) 81 763 1030 and Fax (+44) 81 763 1005.

Tony Cullen Christopher F Foss May 1993

Abbreviations

AA AAAV	anti-aircraft Advanced Amphibious Assault	APSE APSE-T	armour-piercing secondary effect armour-piercing secondary effect-	CENTCOM CET	Central Command Combat Engineer Tractor
	Vehicle		tracer	CEV	combat engineer vehicle
AAG AAK	anti-aircraft gun Appliqué Armor Kit (US)	APTE	armour-piercing tracer Abrams Power Train Evolution (US)	CFV CFV	controlled fragmentation Cavalry Fighting Vehicle (US)
AAV	Assault Amphibian Vehicle	APU	auxiliary power unit	CGS	Crew Gunnery Simulator
ACCV	Armored Cavalry Cannon Vehicle (US)	APV	armoured patrol vehicle	CHARM	Challenger Chieftain Armament
ACE	Armored Combat Earthmover (US)	AR/AAV	Armored Reconnaissance/Airborne	CHIP	Challenger Improvement
ACEC	Ateliers de Constructions Électriques de Charleroi	ARDEC	Assault Vehicle (US) Armament Research Development	CILAS	Programme Compagnie Industrielle des Lasers
ACLOS	Automatic-to-Command	ANDEC	and Engineering Centre	CIS	Chartered Industries of Singapore
	Line-of-Sight	ARDNOT	Automatic Day/Night Optical	CITY	Commander's Independent
ACRV	armoured command and	4 DE	Tracker Atelier de Construction Roanne	CHEC	Thermal Viewer (US)
ACV	reconnaissance vehicle Armored Cannon Vehicle (US)	ARE ARETS	Armour Remoted Target System	CLAMS	Close-In Weapons System Clear Lane Marking System (US)
ACV	Armoured Combat Vehicle	ARMAD	Armoured and Mechanised Unit	CLAWS	Close Combat Light Armor Weapon
ACVT	Armored Combat Vehicle		Air Defence		System (US)
ADAM	Technology Programme (US)	ARMSCOR	Armament Manufacturing	CLGP	Cannon-Launched Guided
ADAMS	Area Denial Artillery Munition Air Defense Advanced Mobile	ARMVAL	Corporation (South Africa) Anti-Armor Vehicle Evaluation (US)	CMV	Projectile (US) Combat Mobility Vehicle (US)
	System	ARP	anti-radiation projectile	Comp B	Composition B
ADATS	Air Defence Anti-Tank System	ARRADCOM	Armament Research and	COMVAT	Combat Vehicles Armament
ADEA	Army Development and Employment Agency	ARRV	Development Command Armoured Repair and Recovery	CORAD	Technology (US) Co-ordinated Roland Air Defence
AEV	armoured engineer vehicle	AKKY	Vehicle	COTAC	Conduite de Tir Automatique pour
AF	air force	ARSV	Armored Reconnaissance Scout		Char (tank automatic fire)
AFAP	artillery-fired atomic projectile		Vehicle (US)	COV	Counter Obstacle Vehicle (US)
AFARV	Armored, Forward Area, Re-arm	ARV ASA	armoured recovery vehicle	CPV CPV	concrete-piercing
AFAS	Vehicle (US) Advanced Field Artillery System	ASARC	Advanced Security Agency Army Systems Acquisition Review	CRARRY	command post vehicle Challenger Repair and Recovery
AFD	automatic feeding device		Council		Vehicle
AFF	Ammunition Factory Footseray	ASM	Armored Systems Modernization (US)	CRR	Carro de Reconhecimento Sobre
AFSV	Armoured Fire Support Vehicle	ASTROS	Artillery Saturation Rocket System		Rodas (reconnaissance tracking scout
AFV AFV	Armored Family of Vehicles (US) armoured fighting vehicle	ASV AT	ammunition supply vehicle anti-tank	CRT	car)
AGF	Army Ground Forces	ATACS	Advanced Tank Cannon System (US)	CSB	cathode ray tube Combat Support Boat
AGL	above ground level	ATDU	Armoured Trials & Development	CSF	Combined Service Forces
AGLS	Automatic Gun Laying System		Unit	CSI	computer synthesised image
AGS	Armored Gun System (US)	ATG	anti-tank gun	CSS	Computer Sighting System
AGV AGVT	Assault Gun Vehicle Advanced Ground Vehicle	ATGW ATLV	anti-tank guided weapon Artillery Target Location Vehicle	CTI CTRA	Central Tyre Inflation Carro de Transporte Sobre Rodas
AGTI	Technology	ATM	anti-tank mine	CIRA	Anfibo (amphibious tracking scout car)
Ah	ampère hour	ATR	Automotive Test Rig	CTT	Challenger Training Tank
AIFS	Advanced Indirect Fire System	ATS	Atelier de Construction de Tarbes	CVAST	Combat Vehicle Armament System
AIFV AIFV	Armored Infantry Fighting Vehicle (US)	ATTS	Air-Transportable Towed System	CUBBE	Technology (US)
AIPS	armoured infantry fighting vehicle Advanced Integrated Propulsion	AVGP AVH	Armoured Vehicle General Purpose Armoured Vehicle Heavy	CVRDE	Combat Vehicle Research and Development Establishment
	System (US)	AVL	Armoured Vehicle Light	CVR(T)	Combat Vehicle Reconnaissance
ALAAVS	Advanced Light Armored/	AVM	Armoured Vehicle Medium		(Tracked)
ALT	Amphibious Vehicle System (US)	AVLB	armoured vehicle-launched bridge	CVR(W)	Combat Vehicle Reconnaissance
AMCCOM	Armoured Launching Turret Armament Munitions and Chemical	AVR AVRE	armoured vehicle reconnaissance Assault Vehicle Royal Engineers	CVT	(Wheeled) controlled variable time
100,000,000	Command		The state of the s	CWR	continuous wave radar
AMDS	Anti-missile Discarding Sabot	cic whether		CWS	cupola weapon station
AMF	Amphibische Mehrzweck- Fahrzeuge (multi-purpose amphibious	BAOR BARV	British Army of the Rhine Beach Armoured Recovery Vehicle		
	vehicle)	BATES	Battlefield Artillery Target	DARCOM	US Army Materiel Development
AML.	Automitrailleuse Légère (light		Engagement System	D. M.C.O.	and Readiness Command
	armoured car)	BB	base bleed	DARPA	Defense Advanced Research Projects
AMR			battery control centre		Agency
	Automitrailleuse de	BCC		DCA	Defense Coutes tolone lasti
AMX	Reconnaissance	BD	base detonating	DCA	Defense Contre Avions (anti-
AMX				DCA DDA	Defense Contre Avions (anti- aircraft) Detroit Diesel Allison
AMX AOI	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for	BD BE bhp BITE	base detonating base ejection brake horsepower built-in test equipment	DDA DDS	aircraft) Detroit Diesel Allison Department of Defense Support
AOI	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation	BD BE bhp BITE BL	base detonating base ejection brake horsepower built-in test equipment blank	DDA DDS DDU	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit
AOI AOS	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation	BD BE bhp BITE BL BLR	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas	DDA DDS	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications
AOI	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation	BD BE bhp BITE BL	base detonating base ejection brake horsepower built-in test equipment blank	DDA DDS DDU	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit
AOI AOS AP APAM APC	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation armour-piercing anti-personnel, anti-materiel armoured personnel carrier	BD BE bhp BITE BL BLR BL-T BMARC	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas blank tracer British Manufacture and Research Company	DDA DDS DDU DEFA DESO DFCS	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications d'Armement Defence Export Sales Organisation Digital Fire Control System
AOI AOS AP APAM APC APC	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation armour-piercing anti-personnel, anti-materiel armoured personnel carrier armour-piercing capped	BD BE bhp BITE BL BLR BL-T BMARC BMF	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas blank tracer British Manufacture and Research Company Belgian Mechanical Fabrication	DDA DDS DDU DEFA DESO DFCS DFSV	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications d'Armement Defence Export Sales Organisation Digital Fire Control System Direct Fire Support Vehicle
AOI AOS AP APAM APC APC APC-T	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation armour-piercing anti-personnel, anti-materiel armour-piercing capped armour-piercing capped armour-piercing capped	BD BE bhp BITE BL BLR BL-T BMARC BMF BMR	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas blank tracer British Manufacture and Research Company Belgian Mechanical Fabrication Blindado Medio de Ruedas	DDA DDS DDU DEFA DESO DFCS DFSV DHSS	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications d'Armement Defence Export Sales Organisation Digital Fire Control System Direct Fire Support Vehicle Data Handling Sub-System
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AOI AOS AP APAM APC APC APC-T	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation armour-piercing anti-personnel, anti-materiel armoured personnel carrier armour-piercing capped armour-piercing capped tracer armour-piercing capped tracer	BD BE bhp BITE BL BLR BL-T BMARC BMF BMR BMS	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas blank tracer British Manufacture and Research Company Belgian Mechanical Fabrication Blindado Medio de Ruedas	DDA DDS DDU DEFA DESO DFCS DFSV DHSS DIA	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications d'Armement Defence Export Sales Organisation Digital Fire Control System Direct Fire Support Vehicle Data Handling Sub-System
AOI AOS AP APAM APC APC APC-T APCI-BF	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation armour-piercing anti-personnel, anti-materiel armour-piercing capped armour-piercing capped armour-piercing capped tracer armour-piercing capped tracer armour-piercing capped tracer armour-piercing discarding sabot armour-piercing discarding sabot	BD BE bhp BITE BL BLR BL-T BMARC BMF BMR BMS BMS BNS	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas blank tracer British Manufacture and Research Company Belgian Mechanical Fabrication Blindado Medio de Ruedas Battlefield Management Systems Bill Night Sight Battery Operations Centre Vehicle Bofors Optronic Fire control	DDA DDS DDU DEFA DESO DFCS DFSV DHSS DIA DIVADS DoD DOP	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications d'Armement Defence Export Sales Organisation Digital Fire Control System Direct Fire Support Vehicle Data Handling Sub-System Defense Intelligence Agency (US) Division Air Defense Gun System (US) Department of Defense (US) Department of Productivity
AOI AOS AP APAM APC APC APC-T APCI-BF APDS APDS-T	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation armour-piercing anti-personnel, anti-materiel armour-piercing capped armour-piercing capped armour-piercing capped tracer armour-piercing capped tracer armour-piercing capped tracer armour-piercing discarding sabot armour-piercing discarding sabot tracer	BD BE bhp BITE BL BLR BL-T BMARC BMF BMR BMS BOCV BOFI	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas blank tracer British Manufacture and Research Company Belgian Mechanical Fabrication Blindado Medio de Ruedas Battlefield Management Systems Bill Night Sight Battery Operations Centre Vehicle Bofors Optronic Fire control Instrument	DDA DDS DDU DEFA DESO DFCS DFSV DHSS DIA DIVADS DoD	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications d'Armement Defence Export Sales Organisation Digital Fire Control System Direct Fire Support Vehicle Data Handling Sub-System Defense Intelligence Agency (US) Division Air Defense Gun System (US) Department of Defense (US) Department of Productivity Dual Purpose Improved
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AOI AOS AP APAM APC APC APC-T APCI-BF APDS APDS-T	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation armour-piercing anti-personnel, anti-materiel armour-piercing capped armour-piercing capped armour-piercing capped tracer armour-piercing capped tracer armour-piercing capped tracer armour-piercing discarding sabot armour-piercing discarding sabot tracer	BD BE bhp BITE BL BLR BL-T BMARC BMF BMR BMS BOCV BOFI	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas blank tracer British Manufacture and Research Company Belgian Mechanical Fabrication Blindado Medio de Ruedas Battlefield Management Systems Bill Night Sight Battery Operations Centre Vehicle Bofors Optronic Fire control Instrument	DDA DDS DDU DEFA DESO DFCS DFSV DHSS DIA DIVADS DoD DOP	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications d'Armement Defence Export Sales Organisation Digital Fire Control System Direct Fire Support Vehicle Data Handling Sub-System Defense Intelligence Agency (US) Division Air Defense Gun System (US) Department of Defense (US) Department of Productivity Dual Purpose Improved
AOI AOS AP APAM APC APC APC-T APCI-BF APDS APDS-T APE APERS	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation armour-piercing anti-personnel, anti-materiel armour-piercing capped armour-piercing capped tracer armour-piercing capped tracer armour-piercing capped tracer armour-piercing discarding sabot armour-piercing discarding sabot tracer Amphibisches Pionier- Erkundungsfahrzeug (amphibious front line reconnaissance vehicle) anti-personnel	BD BE bhp BITE BL BLR BL-T BMARC BMF BMR BMS BOS BOCV BOFI BTA	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas blank tracer British Manufacture and Research Company Belgian Mechanical Fabrication Blindado Medio de Ruedas Battlefield Management Systems Bill Night Sight Battery Operations Centre Vehicle Bofors Optronic Fire control Instrument best technical approach	DDA DDS DDU DEFA DESO DFCS DFSV DHSS DIA DIVADS DoD DOP DPICM	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications d'Armement Defence Export Sales Organisation Digital Fire Control System Direct Fire Support Vehicle Data Handling Sub-System Defense Intelligence Agency (US) Division Air Defense Gun System (US) Department of Defense (US) Department of Productivity Dual Purpose Improved Conventional Munition (US) Direct Support Armored Cannon System (US) Direct Support Electrical Test
AOI AOS AP APAM APC APC APC-T APCI-BF APDS APDS-T APE APERS APERS-T	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation armour-piercing anti-personnel, anti-materiel armour-piercing capped armour-piercing capped tracer armour-piercing capped tracer armour-piercing capped tracer armour-piercing discarding sabot armour-piercing discarding sabot tracer Amphibisches Pionier- Erkundungsfahrzeug (amphibious front line reconnaissance vehicle) anti-personnel anti-personnel	BD BE bhp BITE BL BLR BL-T BMARC BMF BMR BMS BOFI BTA CAD CAF	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas blank tracer British Manufacture and Research Company Belgian Mechanical Fabrication Blindado Medio de Ruedas Battlefield Management Systems Bill Night Sight Battery Operations Centre Vehicle Bofors Optronic Fire control Instrument best technical approach computer assisted design Canadian Armed Forces	DDA DDS DDU DEFA DESO DFCS DFSV DHSS DIA DIVADS DoD DOP DPICM DSACS DSETS	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications d'Armement Defence Export Sales Organisation Digital Fire Control System Direct Fire Support Vehicle Data Handling Sub-System Defense Intelligence Agency (US) Division Air Defense Gun System (US) Department of Defense (US) Department of Productivity Dual Purpose Improved Conventional Munition (US) Direct Support Armored Cannon System (US) Direct Support Electrical Test System
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AOI AOS AP APAM APC APC APC-T APCI-BF APDS APDS-T APE APERS APERS-T APFIDS APFSDS	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation armour-piercing anti-personnel, anti-materiel armour-piercing capped armour-piercing capped tracer armour-piercing capped tracer armour-piercing capped tracer armour-piercing discarding sabot armour-piercing discarding sabot tracer Amphibisches Pionier- Erkundungsfahrzeug (amphibious front line reconnaissance vehicle) anti-personnel anti-personnel tracer armour-piercing fragmentation incendiary discarding sabot armour-piercing fin-stabilised discarding sabot	BD BE bhp BITE BL BLR BL-T BMARC BMF BMR BMS BOS BOCV BOFI BTA CAD CAF CAL CAP CAI/FCS	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas blank tracer British Manufacture and Research Company Belgian Mechanical Fabrication Blindado Medio de Ruedas Battlefield Management Systems Bill Night Sight Battery Operations Centre Vehicle Bofors Optronic Fire control Instrument best technical approach computer assisted design Canadian Armed Forces Canadian Arsenals Limited Combustible Augmented Plasma Command Adjusted Trajectory/ Fire Control System (US)	DDA DDS DDU DEFA DESO DFCS DFSV DHSS DIA DIVADS DoD DOP DPICM DSACS DSETS DSO DS/T	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications d'Armement Defence Export Sales Organisation Digital Fire Control System Direct Fire Support Vehicle Data Handling Sub-System Defense Intelligence Agency (US) Division Air Defense Gun System (US) Department of Defense (US) Department of Productivity Dual Purpose Improved Conventional Munition (US) Direct Support Armored Cannon System (US) Direct Support Electrical Test System Defence Sales Organisation practice discarding sabot/tracer Division Support Weapon System Direction Technique des
AOI AOS AP APAM APC APC-T APCI-BF APDS APDS-T APE APERS APERS-T APFIDS	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation armour-piercing anti-personnel, anti-materiel armoured personnel carrier armour-piercing capped armour-piercing capped tracer armour-piercing capped tracer – base fuze armour-piercing discarding sabot armour-piercing discarding sabot tracer Amphibisches Pionier- Erkundungsfahrzeug (amphibious front line reconnaissance vehicle) anti-personnel anti-personnel tracer armour-piercing fragmentation incendiary discarding sabot armour-piercing fin-stabilised discarding sabot armour-piercing fin-stabilised	BD BE bhp BITE BL BLR BL-T BMARC BMF BMR BMS BOCV BOFI BTA CAD CAF CAL CAP	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas blank tracer British Manufacture and Research Company Belgian Mechanical Fabrication Blindado Medio de Ruedas Battlefield Management Systems Bill Night Sight Battery Operations Centre Vehicle Bofors Optronic Fire control Instrument best technical approach computer assisted design Canadian Armed Forces Canadian Armed Forces Canadian Armed Forces Canadian Argenals Limited Combustible Augmented Plasma Command Adjusted Trajectory/ Fire Control System (US) Combined Arms Team/Lightweight	DDA DDS DDU DEFA DESO DFCS DFSV DHSS DIA DIVADS DoD DOP DPICM DSACS DSETS DSO DS/T DSWS DTAT	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications d'Armement Defence Export Sales Organisation Digital Fire Control System Direct Fire Support Vehicle Data Handling Sub-System Defense Intelligence Agency (US) Division Air Defense Gun System (US) Department of Defense (US) Department of Productivity Dual Purpose Improved Conventional Munition (US) Direct Support Armored Cannon System (US) Direct Support Electrical Test System Defence Sales Organisation practice discarding sabot/tracer Division Support Weapon System Direction Technique des Armements Terrestres
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AOI AOS AP APAM APC APC APC-T APCT-BF APDS APDS-T APE APERS APERS-T APFIDS APFSDS APFSDS(P) APFSDS-T APG APGM APHE	Reconnaissance Atelier de Construction d'Issy-les- Moulineaux Arab Organisation for Industrialisation add-on stabilisation armour-piercing anti-personnel, anti-materiel armoured personnel carrier armour-piercing capped armour-piercing capped tracer armour-piercing capped tracer armour-piercing discarding sabot armour-piercing discarding sabot tracer Amphibisches Pionier- Erkundungsfahrzeug (amphibious front line reconnaissance vehicle) anti-personnel anti-personnel tracer armour-piercing fragmentation incendiary discarding sabot armour-piercing fin-stabilised discarding sabot armour-piercing fin-stabilised discarding sabot (practice) armour-piercing fin-stabilised discarding sabot tracer Aberdeen Proving Grounds Autonomous Precision-Guided Munition armour-piercing high explosive	BD BE bbp BITE BL BLR BL-T BMARC BMF BMR BMS BOCV BOFI BTA CAD CAF CAL CAP CAT/FCS CAT/LCV CATT-B CAWS CBC CCC CCTV	base detonating base ejection brake horsepower built-in test equipment blank Blindado Ligero de Ruedas blank tracer British Manufacture and Research Company Belgian Mechanical Fabrication Blindado Medio de Ruedas Battlefield Management Systems Bill Night Sight Battery Operations Centre Vehicle Bofors Optronic Fire control Instrument best technical approach computer assisted design Canadian Armed Forces Compustible Augmented Plasma Command Adjusted Trajectory/ Fire Control System (US) Combined Arms Team/Lightweight Combat Vehicle (US) Component Advanced Technology Test-Bed (US) Cannon Artillery Weapons Systems (US) Companhia Brasileira de Cartuchos combustible cartridge case closed-circuit TV	DDA DDS DDU DEFA DESO DFCS DFSV DHSS DIA DIVADS DoD DOP DPICM DSACS DSETS DSO DS/T DSWS DTAT DU DWFK	aircraft) Detroit Diesel Allison Department of Defense Support digital display unit Direction des Études et Fabrications d'Armement Defence Export Sales Organisation Digital Fire Control System Direct Fire Support Vehicle Data Handling Sub-System Defense Intelligence Agency (US) Division Air Defense Gun System (US) Department of Defense (US) Department of Productivity Dual Purpose Improved Conventional Munition (US) Direct Support Armored Cannon System (US) Direct Support Electrical Test System Defence Sales Organisation practice discarding sabot/tracer Division Support Weapon System Direction Technique des Armements Terrestres depleted uranium Deep Water Fording Kit Engin Blindé Gênie (armoured combat vehicle) Engin Blindé de Reconnaissance
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ABBREVIATIONS

EFAB	Établissement d'Etudes et de Fabrications d'Armement de	GCT	Grande Cadence de Tir (high rate of fire)	HSTV(L)	High Survivability Test Vehicle (Lightweight) (US)
	Bourges	GD	General Dynamics	НТТВ	High Technology Test Bed (US)
EFC	equivalent full charge	GD, LSD	General Dynamics, Land Systems	HVAP	high velocity armour-piercing
EFCR	equivalent full charge rounds	nev.	Division	HVAPDS-T	high velocity armour-piercing
EFM EFP	Explosives Factory Maribyrnong	GDU GEMAG	Gun Display Unit General Electric Mobile Air	HVAPFSDS	discarding sabot tracer
EFP	Expanded Feasibility Phase Explosively Formed Penetrator	GEWIAG	Defense Gun	HVAPFSDS	high velocity armour-piercing fin- stabilised discarding sabot
ELKE	Elevated Kinetic Energy Weapon (US)	GH	gun/howitzer	HVAP-T	high velocity armour-piercing tracer
ELS	Electro-magnetic Launcher System	GIAT	Groupement Industriel des	HVM	Hypervelocity Missile
ELSAP	Elektronische Schiessanlage für		Armements Terrestres	HVMS	Hypervelocity Support Weapon
	Panzer (electronic fire system for tanks)	GLC	gun lay computer	HVSD	High Value Sight Defense (US)
EMC EMC	electro-magnetic Executive Management Committee	GLH-H GLLD	Ground-Launched Hellfire-Heavy (US) Ground Laser Locator Designator (US)	HVSS HVTP-T	horizontal volute spring suspension high velocity target practice tracer
EMDG	Euromissile Dynamics Group	GLED	Gesellschaft für Logistischen	HVIF-1	liight velocity target practice tracer
EMG	externally mounted gun	420	Service		
EMP	electro-magnetic pulses	GMC	General Motors Corporation	IAFV	infantry armoured fighting vehicle
ENGESA	Engesa Engenheiros Especializados	GOCO	government-owned, contractor-	IAI	Israel Aircraft Industries
EOD	explosive ordnance disposal	C.D.	operated (US)	IASD	Instant Ammunition Selection
EPC	Engin Principal de Combat (future main battle tank)	GP GPMG	guided projectile General Purpose Machine Gun	ICC	Device information co-ordination centre
EPC	electronic plane conversion	GPO	gun position officer	ICM	improved conventional munition
EPG	European Production Group	GPS	gunner's primary sight	ICM BB	improved conventional munition
EPG	European Programme Group	GSR	General Staff Requirement (US)		base bleed
ER	enhanced radiation	GSRS	General Support Rocket System	ICV	Infantry Combat Vehicle
ER	extended range	GST	General Staff Target	IDF	Israel Defence Forces
ERA ERC	extended range ammunition Engin de Reconnaissance Canon	GST GTCS	Gesellschaft für System-Technik Gun Test and Control System	IEPG	Independent European Program Group
ERFB	extended range full bore	GTI	German Tank Improvement	IFCS	Integrated Fire Control System
ERGP	extended range guided projectile	GW	guided weapon	IFF	Identification Friend or Foe
ERMIS	Extended Range Modification			IFV	infantry fighting vehicle
	Integration System			IFVwCM	Infantry Fighting Vehicle with
ESD	Electronique Serge Dassault	HAB	Heavy Assault Bridge (US)	Tau	Integrated Countermeasures (US)
ESRS	electro slag refined steel	HAWK	Homing-all-the-way-killer (US)	11	image intensification
ERSC ERV	extended range sub-calibre emergency rescue vehicle	HB HC	heavy barrel high capacity	ILL IMI	illuminating Israel Military Industries
ESPAWS	Enhanced Self-Propelled Artillery	HCER	high capacity extended range	IOC	initial operational capability
LOXIVIO	Weapons System (US)	HCHE	high capacity high explosive	IPF	Initial Production Facility
EW	electronic warfare	HCT	HOT Compact Turret	IPO	International Programme Office
EWK	Eisenwerke Kaiserslautern	HE	high explosive	IR	infra-red
*****	Göppner	HE-APERS-		IRBM	intermediate-range ballistic missile
EWS	external weapon station	FRAG	high explosive anti-personnel	IS	internal security
		HEAP-T	fragmentation high explosive anti-personnel	ISV	Internal Security Vehicle Improved TOW Vehicle (US)
		III.AI-I	tracer	IVPDL.	Inter-Vehicle Positioning and Data
FAAD	Forward Area Air Defense (US)	HEAT	high explosive anti-tank		Link (US)
FAAR	Forward Area Alerting Radar (US)	HEAT-FS	high explosive anti-tank fin-	IWS	Improved Weapon System
FAASV	Field Artillery Ammunition		stabilised		
E. CE	Support Vehicle (US)	HEAT-MP	high explosive anti-tank multi-	LOCKE	I C ICED C
FACE	Field Artillery Computer	HEAT-MP(P)	purpose high explosive anti-tank multi-	JGSDF	Japanese Ground Self-Defence Force
FARS	Equipment field artillery rocket system	TEAL-WIF(P)	purpose (practice)	JPO	Joint Project Office
FARV-A	Future Armored Resupply	HEAT-T	high explosive anti-tank tracer	JSC	Joint Steering Committee
	Vehicle - Artillery (US)	HEAT-T-HVY	high explosive anti-tank tracer heavy	JSDFA	Japanese Self-Defence Force
FAST	Forward Area Support Team	HEAT-TP-T	high explosive anti-tank target practice		Agency
FAV	Fast Attack Vehicle (US)		tracer		
FCC	Fire Command Centre	HEAT-T-MP	high explosive anti-tank tracer	KE	14 - 45
FCCVS	Future Close-Combat Vehicle System (US)	HEDP	multi-purpose high explosive dual purpose	KE KEM	kinetic energy Kinetic Energy Missile (US)
FCE	fire control equipment	HEER	High Explosive Guar purpose High Explosive Extended Range (US)	KIFV	Korean Infantry Fighting Vehicle
FCS	fire control system	HE-FRAG	high explosive fragmentation	-	110.000
FDC	fire direction centre	HE-FRAG-FS	high explosive fragmentation - fin-		
FDCV	fire direction centre vehicle		stabilised	LAAG	light anti-aircraft gun
FEBA	Forward Edge Battlefield Area	HE-FS	high explosive – fin-stabilised high explosive incendiary	LADS LADS	light aid detachment
FG FH	field gun field howitzer	HEIT	high explosive incendiary tracer	LAPES	light air defense system (US) Low Altitude Parachute Extraction
FIFV	Future Infantry Fighting Vehicle (US)	HEL	High Energy Laser (US)	LIKE LO	System
FISTV	Field Support Team Vehicle (US)	HEL	Human Engineering Laboratory (US)	LATS	Light Armoured Turret System
FITOW	Further Improved TOW (US)	HELP	Howitzer Extended Life Program (US)	LAV	Light Armored Vehicle (US)
FLIR	forward-looking infra-red	HEMAT	Heavy Expanded Mobility	LAV	Light Assault Vehicle (US)
FLOT	forward line of own troops Food Machinery Corporation	НЕМТТ	Ammunition Trailer (US) Heavy Expanded Mobility Tactical	LAW LED	light anti-tank weapon light emitting diode
FMS	Foreign Military Sales	HEAVITT	Truck (US)	LEW	Lyttleton Engineering Works
FN	Fabrique Nationale	HEP	high explosive plastic	LIA	Linear Induction Accelerator
FOO	forward observation officer	HEPD	high explosive point detonating	LLAD	low level air defence
FOV	field-of-view	HE/PR	high explosive practice	LLLTV	low-light level television
FRAG	fragmentation	HEP-T	high explosive practice tracer	LMG	light machine gun
FROG	free rocket over ground fire support combat vehicle	HERA HE-S	high explosive rocket-assisted high explosive spotting	LOSL	Lock-On Before Launch Line-of-Sight
FSED	full-scale engineering development (US)	HESH	high explosive squash head	LOSAT	Line-of-Sight Anti-tank
FST	Future Soviet Tank/Follow-on	HESH-T	high explosive squash head tracer	LP	Liquid Propellant
	Soviet Tank	HE-T	high explosive tracer	LPC	Launcher Pod Carrier
FSV	fire support vehicle	HET-PF	high explosive tracer - percussion	LPTS	Lightweight Protected Turret
FTMA	Future Tank Main Armament	HETER	fuze	LDAT	System
FTS FUG	Future Tank Study Felderitö Usó Gépkosci	HE-T SD HFCC	high explosive tracer – self-destruct Howitzer Fire Control Computer (US)	LRAT LRBB	long-range anti-tank long-range base bleed
FV	fighting vehicle	HFHTB	Human Factors Howitzer Test-Bed (US)	LRF	Low Recoil Force
FV/GCE	fighting vehicle gun control	HFM	Heavy Force Modernisation (US)	LRHB	long-range hollow base
	equipment	HIMAG	High-Mobility Agility Test Vehicle (US)	LRN	Low Recoil Noricum
FVRDE	Fighting Vehicle Research and	HMC	Howitzer Motor Carriage	LRU	line-replaceable unit
EVEC	Development Establishment	HIP	Howitzer Improvement Programme (US)	LTD	laser target designator
FVSC FVS	Fighting Vehicle Systems Carrier (US) Fighting Vehicle System (US)	HMLC How	High Mobility Load Carrier howitzer	LTFCS LVA	Laser Tank Fire Control System landing vehicle assault (US)
FY	fiscal year	hp	horsepower	LVA	landing vehicle tracked (US)
G	gendarmerie	HPFP	High Performance Fragmentation	LVTC	landing vehicle tracked command (US)
GAP	Gun Aiming Post		Projectile	LVTE	landing vehicle tracked engineer (US)
GAO	General Accounting Office	HPS	Helmet Pointing System (or Sight)	LVTH	landing vehicle tracked howitzer (US)
GCE	gun control equipment	HPT	high-pressure test	LVTP	landing vehicle tracked personnel (US)

LVTR LWML LWMS	landing vehicle tracked recovery (US) Light Weight Multiple Launcher Light Weight Modular Sight	PCB PD PE	printed circuit board point detonating Procurement Executive	SEN SFCS SFIM	shell extended range NORICUM Simplified Fire Control System Société de Fabrication d'Instrument
LWT	light weapon turret	PFD PFHE	proximity fuze disconnector	SFIRR	de Mesure solid fuel integral rocket/ramjet
		PFPX	pre-fragmented high explosive pre-fragmented proximity fuzed	SFIRK	Sensor Fuzed Munitions
MAC	Medium Armored Car (US)	P How	pack howitzer	SHORAD	Short Range Air Defence System
MADLS	Mobile Air Defence Launching System	PIE PIVADS	pyrotechnically initiated explosive Product Improved Vulcan Air	SH/PRAC shp	squash head practice shaft horse power
MAOV	Mobile Artillery Observation Vehicle	PLARS	Defense System (US) Position Location and Reporting	SIPS SKOT	Small Integrated Propulsion System Średni Kolowy Opancerzny Transportér
MAP	Military Aid Programme	LAKS	System (US)	SLAP	saboted light armor penetrator
MAV	maintenance assist vehicle main battle area	PLS PM	Palletised Load System (US)	SLEP SLR	Service Life Extension Program (US)
MBA MBB	Messerschmitt-Bölkow-Blohm	PMO	porte mortier (mortar carrier) Program Management Office (US)	SM	Super Low Recoil smoke
MBT	main battle tank	POS	Postes Optiques de Surveillance	SMCO	Standard Manufacturing Company
MCCS	Marconi Command and Control Systems	PPI PRAC	plan position indicator practice	SMG Smoke BE	sub-machine gun smoke base ejection
MCRV	Mechanised Combat Repair Vehicle	PRAC-T	practice tracer	Smoke WP	smoke white phosphorus
MCSK MCT	Mine Clearance System Kit (US) Medium Combat Tractor (US)	PRI PTO	projector reticle image power take-off	SP SPAAG	self-propelled self-propelled anti-aircraft gun
MCT	MILAN Compact Turret	PWI-SR(GR)	Panser Wagen Infanterie-Standaard	SPAAM	self-propelled anti-aircraft missile
MCWS	Minor Calibre Weapons Station (US)		(Groep)	SPAG	self-propelled assault gun
MENS MEV	Mission Element Need Statement (US) medical evacuation vehicle (US)			SPARK	solid propellant advanced ramjet kinetic energy missile
MEWSS	Mobile Electronic Warfare Support	QCB	Quick Change Barrel	SPATG	self-propelled anti-tank gun
MF	System multi-function	QE	quadrant elevation	SPAW SPG	self-propelled artillery weapon self-propelled gun
MFC	mortar fire controller			SPH	self-propelled howitzer
MFF	munition filling factory	RA	Royal Artillery	SPL	self-propelled launcher
MG MGB	machine gun Medium Girder Bridge	RAAMS RAC	Remote Anti-Armor Mine System (US) Royal Armoured Corps	SPM SPSM	self-propelled mortar Sensorgezundete Panzerabwehr
MICOM	Missile Command (US)	RADIRS	Rapid Deployment Multiple Rocket		SubMunition
MICV MILAN	mechanised infantry combat vehicle Missile d'Infantrie Léger Antichar	RAM-D	System (US) reliability, availability,	SRC SRG	Space Research Corporation shell replenishment gear
WILLAND	(light infantry anti-tank missile)	KAM-D	maintainability and durability	SRU	slip ring unit
MILES	Multiple Integrated Laser	RAO	Rear Area Operations	SRV	Surrogate Research Vehicle (US)
MIPS	Engagement System (US) Medium Integrated Propulsion	RAP RARDE	rocket-assisted projectile Royal Armament Research and	SSG SSK	Single Shot Gun Single Shot Kill
	System (US)		Development Establishment	STA	shell transfer arm
MLC MLC	Military Load Class Modular Load Carrier	RATAC RCAAS	Radar for Field Artillery Fire Remote-Controlled Anti-Armor	STAFF	Small Target Activated Fire and Forget (US)
MLRS	Multiple Launch Rocket System (US)		System (US)	STARTLE	Surveillance and Target Acquisition
MMBF MMS	mean miles between failures mast-mounted sight	RCC RCDU	Roland Co-ordination Centre (US) Remote Controlled Defence Unit		Radar for Tank Location and Engagement (US)
MoD	Ministry of Defence	RCT	Royal Corps of Transport	STE/ICE	Simplified Test Equipment/Internal
MOLF	Modular Laser Fire Control	RDF/LT	Rapid Deployment Force Light	carin	Combustion Engine (US)
MoU MPGS	memorandum of understanding Mobile Protected Gun System (US)	RCV	Tank (US) Robotic Command Vehicle	STUP	spinning tubular projectile
MPWS	Mobile Protected Weapon System (US)	RDJTF	Rapid Deployment Joint Task		
MPS MRBF	Maritime Prepositioning Ships (US) mean rounds before failure	RDT&E	Force (US) Research Development Test and	TACMS TACOM	Army Tactical Missile System (US) Tank Automotive Command (US)
MRS	multiple rocket system	RDIGE	Evaluation	TAD	Trailing Arm Drive (US)
MRS	muzzle reference system	REME	Royal Electrical and Mechanical	TADDS	Target Alert Display Data Set (US)
MRVR	Mechanised Repair and Recovery Vehicle (US)	RFP	Engineers request for proposals	TADS	Target Acquisition and Designation System (US)
MSDS	Marconi Space and Defence Systems	RHA	rolled homogeneous armour	TAM	Tanque Argentino Mediano
MSTAR	Manportable Surveillance and Target Acquisition Radar	RHA RISE	Royal Horse Artillery Reliability Improved Selected	TAS TAT-251	Tracking adjunct system Tactical Armament Turret 25 mm.
MSV	Modular Support Vehicle	KISE	Equipment	1201	I man (US)
MT MTB	mechanical time	RMG	ranging machine gun	TBAT	TOW/Bushmaster Armored Turret (US)
MTI	Mobility Test-Bed moving target indication	RO ROBAT	Royal Ordnance Robotic Counter-Obstacle Vehicle (US)	TD	tactical control unit tank destroyer
MTL	Materials Technology Laboratory (US)	ROC	required operational characteristics	TDCS	Tank Driver Command System
MTR MTSO	Mobile Test Rig (US) mechanical time and superquick	RoC ROF	Republic of China rate of fire	TDR	Target Data Receiver Transporter, Erector, Launcher
MTU	Motoren-und-Turbinen-Union	RoK	Republic of Korea	TELAR	Transporter, Erector, Launcher
MULE	Modular Universal Laser	ROKIT	Republic of Korea Indigenous Tank	TES	and Radar
MV	Equipment (US) muzzle velocity	RP	range only radar rocket propelled	TGMTS	target engagement system Tank Gunnery Missile Tracking
MVEE	Military Vehicles and Engineering	RPV	remotely piloted vehicle	TOP	System
MWS	Establishment Manned Weapon Station (US)	RR RSAF	Recoilless Rifle Royal Small Arms Factory	TGP TGS	Terminally Guided Projectile Tank Gun Sight
		RSS	Rosette Scanning Seeker	TGSM	terminally guided submunition
NATO	North Atlantic Treaty Organisation	RUC	Roues Transporteur de Troupes Royal Ulster Constabulary	TGTS	tank gunnery training simulator thermal imaging
NBC	nuclear, biological, chemical	ROC	Royal Olster Constantially	TICM	thermal imaging common modules
NBMR NTC	NATO Basic Military Requirement National Training Center (USA)	SABCA	Société Anonyme Belge de	TIRE TIS	Tank Infra-Red Elbow
NUGP	nominal unit ground pressure	SABCA	Constructions Aéronautiques	TLR	thermal imaging system Tank Laser Rangefinder
		SADARM	Sense And Destroy Armor (US)	TLS	Tank Laser Sight
OBR	Optical Beam Riding	SADF SAE	South African Defence Force Society of Automotive Engineers	TMS	Turret Modernisation System table of organisation and
OCC	Obus à Charge Creuse	SAL	semi-active laser		equipment
ODE	(shaped charge shell) Ordnance Development and	SAM SAMM	surface-to-air missile Société d'Applications des	TOGS	Thermal Observation and Gunnery System
ODL	Engineering (Singapore)	SAMINI	Machines Motrices	TOPAS	Transporter Obrneny Pasovy
OP	observation post	SANTAL	Système Anti-aérien Lèger	TOTE	Tracker. Optical Thermally
OTA OTA	operational test overflight top attack	SAPI	(light anti-aircraft system) semi-armour piercing incendiary	TOW	Enhanced Tube-launched Optically tracked
OTEA	Operational Test and Evaluation	SATCP	Système Anti-aérien à Très Courte Portée		Wire-guided (US)
OVT	Agency (US) Oceonics Vehicle Technology	SCG	(very short-range anti-aircraft system) Self Changing Gears	TP-FL	target practice target practice flash
0,1	occomes remote recimology	SCORE	Stratified Charge Omnivorous	TPFSDS-T	target practice fin-stabilised
P ³ I	Pre-Planned Production Improvements	SD	Rotary Engine self-destruct	TP-SM	discarding sabot tracer
		SEME	School of Electrical and Mechanical	TP-SM	target practice smoke target practice spotting
PAR	pulse acquisition radar	Property and the second			

ABBREVIATIONS

TRACKSTAR	Tracked Search and Target	N/A PN/	Feb. 1		
THACKSTAK	Acquisition Radar System (US)	VARV	Vickers Armoured Recovery	VDU	visual display unit
TRADOC	Training and Doctrine Command (US)	unc	Vehicle	VEC	Vehiculo de Exploración de
TRLV	Tracked Basis Laureh Valida	VBC	Véhicule Blindé de Combat		Caballerie
TRSV	Tracked Rapier Launch Vehicle Tracked Rapier Support Vehicle	* ten *	(armoured combat vehicle)	VEDES	Vehicle Exhaust Dust Ejection
TSFCS		VBI.	Véhicule Blindé Léger		System (US)
131-63	Tank Simplified Fire Control System	N.O.	(light armoured vehicle)	VGMU	Vulcan Gunner Monitor Unit (US)
TSQ		VCA	Véhicule Chenillé	VHIS	visual hit indicator system
TT	time and superquick		d'Accompagnement (tracked	VIB	Véhicule d'Intervention du Base
1.1	transport de troupes (troop	- COMMAN	support vehicle)	VIRSS	Visual and Infra-Red Smoke
TTB	transporter)	VCC	Veicolo Corazzato de		Screening System
	Tank Test-Bed (US)		Combattimento	VLC	Véhicule Léger de Combat (light
TIS	Tank Thermal Sight	VCG	Véhicule de Combat du Genie		armoured car)
TUA	TOW Under Armor (US)		(armoured engineer vehicle)	VMBT	Vickers Main Battle Tank
TUR	Tiefflieger-Überwachungs-radar	VCI	Véhicule de Combat d'Infanterie:	VRL	Véhicule Reconnaissance Léger
	(low level surveillance radar)		Vehiculo combate infanteria		(light reconnaissance vehicle)
TWMP	Track Width Mine Plough		(infantry combat vehicle)	VSEL	Vickers Shipbuilding and
		VCR	Véhicule de Combat à Roues		Engineering Ltd
			(wheeled combat vehicle)	VT	variable time
UDR	Ulster Defence Regiment	VCR	variable compression ratio	VTP	véhicule transport de personnel
UET	Universal Engineer Tractor (US)	VCR/AT	Véhicule de Combat à Roues/Atelier		(personnel carrier)
ULC	Unit Load Container		Véhicule	VIT	véhicule transport de troupe
USAADS	US Army Air Defense School	VCR/IS	Véhicule de Combat à Roues/	***	(troop transporter)
USMC	United States Marine Corps		Intervention Sanitaire	VVSS	vertical volute spring suspension
USN	United States Navy	VCR/PC	Véhicule de Combat à Roues/Poste	VWC	Vulcan Wheeled Carrier (US)
UTS	Universal Turret System		de Commandement	VXB	Véhicule Blindé à Vocations
	Chiversal Turret System	VCR/TH	Véhicule de Combat à Roues/	1.00	
			Tourelle HOT		Multiples (multi-purpose armoured
		VCR/TT	Véhicule de Combat à Roues/		car)
VAB	Véhicule de l'Avant Blindé (front	7 (Sept. 19. 19. 19. 19. 19. 19. 19. 19. 19. 19	Transport de Troupes		
	armoured car)	VCTM	Vehiculo de Combate Transporte de	WAM	Wide Area Mines (US)
VAB	Vickers Armoured Bridgelayer		Mortero (armoured mortar carrier)	WAPC	Wheeled Armoured Personnel
VADAR	Véhicule Autonome de Défense	VCTP	Vehiculo de Combate Transporte de		Carrier
	Anti-aérienne Rapproché	· CII		WARPAC	Warsaw Pact
	(autonomous close-action anti-		Personal (armoured personnel carrier)	WFSV	Wheeled Fire Support Vehicle
	aircraft vehicle)	VDA	CAST 1.00 (A.)	WMRV	Wheeled Maintenance and
VADS	Vulcan Air Defense System (US)	V DA	Véhicule de Defense Anti-aérienne	No works it	Recovery Vehicle
VAE	Vehículo Armado Exploration	VDAA	(anti-aircraft defence vehicle)	WP	white phosphorus
VAPE	Vehiculo APoyo y Exploration	VDAA	Véhicule d'Auto-Défense	WP-T	white phosphorus tracer
VARRV	Vickers Armoured Repair and	WINNE	Anti-aërienne		winte phosphorus tracer
	Recovery Vehicle	VDM	viscous damped mount		
	receivery vehicle	VDSL	Vickers Defense Systems Ltd	YMRS	Yugoslav multiple rocket system

Weapons of 20 mm and Upward

(Weapons in this section are 20 mm or over in calibre, are in production or under development, or are weapons for which production capabilities probably still exist)

ARGENTINA

105 mm FRT L44 D1504 Type CN105F1 Gun

Development/Description

The 105 mm FRT L44 D1504 Type CN105F1 gun is essentially an Argentinian version of the French Giat D1504 gun which was designed by the *Etablissement d'Etudes et de Fabrications d'Armament de Bourges* (EFAB) to meet the requirements of the Israeli Army.

In Argentinian service it has been used to upgun the remaining Sherman MBTs still in front line service that have already been fitted with a new, more fuel efficient diesel engine.

Steel for the home-built weapons is provided by Argentinian Altos Hornos Zapla steelworks.

Types of fixed ammunition fired by the weapon include M60 high explosive, F1 smoke and M60 training and brief details of these are as follows:

Туре	M60 HE	F1 Smoke	M60 Training
PROJECTILE WEIGHT	12 kg	12.8 kg	12 kg
PROJECTILE			
CONTENT	2 kg	1.8 kg	2 kg
PROJECTILE			
FILLING	TNT or Hexolite 50/50	WP	Sulphur- Naphthalene
MUZZLE	1.3.3.5		
VELOCITY	700 m/s	700 m/s	700 m/s
CARTRIDGE			
WEIGHT	18.4 kg	19.1 kg	18.4 kg

Туре	M60 HE	F1 Smoke	M60 Training
PROPELLANT			
WEIGHT	2.4 kg	2.4 kg	2.4 kg
PROPELLANT TYPE			
(imported)	LB 7T 72 (0.8)	LB 7T 72 (0.8)	
(local equivalent)	BD 5	BD 5	BD 5
WORKING PRESSURE	2400 kg/cm ²	2400 kg/cm ²	2400 kg/cm ²

105 mm

SPECIFICATIONS

CALIBRE

LENGTH	4622 mm
LENGTH OF BARREL	
(calibres)	44
LENGTH OF RIFLING	4081 mm
NUMBER OF RIFLING GROOVES	32
TOTAL LENGTH	5150 mm
WEIGHT OF BARREL	735 kg
RECOILING MASS WEIGHT	1065 kg
NORMAL RECOIL	368 mm
MAX RECOIL	384 mm
BREECH MECHANISM	semi-automatic horizontal wedge

BREECH MECHANISM semi-automatic horizontal wedge MAX PRESSURE 3300 kg/cm²

Status: Production as required. In service with Argentina.

Manufacturer: Direccion General de Fabricaciones Militares Argentina, Sales Department, Avenue Cabildo 65 (1462), Buenos Aires, Argentina.

105 mm FRT L51 Tank Gun

Development/Description

This 105 mm rifled tank gun is installed in the TAM medium tank designed by Thyssen Henschel of Germany to meet the requirements of the Argentine Army, with production being undertaken in Argentina by TAMSE. FRT call this weapon the "105 mm L51 gun type L7A3 for TAM tank" although its specifications do not match those of the Royal Ordnance 105 mm L7A3 tank gun.

The L51 is a rifled tank gun fitted with a fume extractor and with a vertical locking wedge mounted on the cradle. The wedge comprises the shield, firing brakes, recuperator, compensator, 7.62 mm coaxial machine gun carriage, gas extractor equipment, support for TZF/LA telescope and quadrant. Mounted under the weapon is a spent cartridge case basket that holds five spent cartridge cases.

The gun fires two main types of ammunition with a fixed cartridge case, APFSDS (Rheinmetall type) with the complete round weighing 18.7 kg with a muzzle velocity of 1455 m/s and an M456 HEAT-T with the complete round weighing 22 kg with a muzzle velocity of 1173 m/s.

SPECIFICATIONS

CALIBRE	105 mm
TOTAL LENGTH	6376 mm
BARREL BORE LENGTH	5346 mm
MAX OUTER DIAMETER	226 mm

RIFLING ANGLE	9°50'
NUMBER OF RIFLING	
GROOVES	28
RIFLING PITCH	constant
WEIGHT	
complete barrel	1306 kg
barrel	760 kg
fume extractor	10 kg
breech	450 kg
locking wedge	60 kg
trunnion carrying plate	138 kg
cradle	462 kg
complete shield	260 kg
shield cover	6 kg
firing brake	53 kg
recuperator	41 kg
gas extractor equipment	21 kg
spent cases box	50 kg
MAX RECOIL	560 mm
MAX PRESSURE	5290 kg/cm ²

Status: Production as required. In service with Argentina.

Manufacturer: Direccion General de Fabricaciones Militares Argentina, Sales Department, Avenue Cabildo 65 (1462), Buenos Aires, Argentina.

BELGIUM

Cockerill 90 mm Gun System

Description

In 1974 the Seraing-based Cockerill company decided to re-enter the defence market by producing a 90 mm gun system suitable for light and medium tanks and armoured cars. The Mark I was followed by the Mark II which differed mainly in having a revised recoil mechanism which increased the length of recoil from 300 to 500 mm to reduce the trunnion force. The Mark III MA1 was introduced in 1986 and has a single-baffle muzzle brake. The Mark I and Mark II weapons are no longer in production.

All three Marks are similar in that they are manufactured from a special electro-slag refined steel, are light, and use a wide range of ammunition. All

three guns use a triple-baffle muzzle brake (except the Mark III MA1 which can fire APFSDS-T projectiles). The Mark III gun has a breech mechanism for re-cocking in the event of a misfire; the Marks I and II do not. Other improvements with the Mark III include the reduction of recoil forces from 13 000 kg to 8500 kg and the introduction of an improved ESR steel to lessen the incidence of barrel cracking. The recoil mechanism is hydroconcentric using two concentric springs, a light but very effective system which enables the large-calibre gun to be mounted in vehicles weighing as little as seven tons.

2 WEAPONS OF 20 mm AND UPWARD / Belgium

Status: Mark III in production. Used or trialled on Cadillac Gage Commando V-150 and V-300, Panhard Sagaie 1 (Hispano-Suiza turret), Warrior (CM 90 turret), OTO Melara C13 (OTO Melara T 90 CKL turret), FMC M113 series (CM 90 turret), Steyr SK 105 light tank (CM 90 turret), Arrowpointe Dragoon 300, MOWAG Piranha 6 × 6 and 8 × 8, Alvis Scorpion, SIBMAS APC, GKN Simba, Vickers Valkyr 4 × 4, EWK 4 × 4, FIAT 6616, Renault VBC 90, Steyr-Daimler-Puch Pandur, PT-76 light amphibious tank, ENASA BMR-600, GLS TPZ 1, and Thyssen Condor. By early 1993 more than 2000 of these weapons had been produced by Cockerill or its licensees. They have been supplied worldwide on all continents except Australia.

Manufacturer: CMI, Cockerill Mechanical Industries SA, Defence Division, Avenue Greiner 1, B-4100 Seraing, Belgium.

Telephone: (041) 30 21 11 Telex: 41 225 Fax: (041) 30 25 26



Cockerill 90 mm Mark III MA1 gun

A modified version of this gun was manufactured in Brazil by ENGESA as the 90 mm EC-90 Gun. Details were given in *Jane's AFV Retrofit Systems* 1992-1993 page 4.

SPECIFICATIONS (Ma	rk III MA1)	NUMBER OF RIFLING		HESH	800 m/s
CALIBRE	90 mm	GROOVES	60	HE	700 m/s
LENGTH		ANGLING OF RIFLING	20' right pitch	smoke	695 m/s
overall	3506 mm	MAX RANGE		HEAT-TPT	890/700 m/s
barrel	3248 mm	effective, HEAT	1500 m	HE APERS-FRAG	320 m/s
rifling	2873 mm	HEAT	2400 m	canister	200 m/s
chamber	375 mm	effective, HESH	1200 m	APFSDS-T	1140 m/s
recoil	300 mm	HESH	1500 m		
WEIGHT		HEAT-TPT	1500 m		
total	456 kg	HE APERS-FRAG	6000 m		
recoiling mass	270 kg	canister	250 m		
barrel	135.5 kg	MUZZLE VELOCITY			
breech, complete	97.6 kg	HEAT-T	900 m/s		
muzzle brake	12.5 kg	HEAT, heavy	700 m/s		

MECAR 90/28 90 mm Light Gun System

Description

The MECAR 90/28 90 mm light gun has been in production for over 30 years and has been sold widely, mainly on the strength of being a very light weapon allied with a wide range of ammunition types in four main groupings. Muzzle velocities are low, as are most combat ranges which are limited to about 1000 m for anti-tank projectiles and 4200 m for anti-personnel high explosive projectiles. Turret mountings produce a recoil force of about 2500 kg which, coupled with a recoil length of 400 mm, means that no muzzle brake is required. The total gun weight is 274 kg, about half that of any equivalent gun system of the same calibre. The recoil system is hydraulic and the breech mechanism is semi-automatically cam-operated with automatic case ejection. Barrel wear and noise signature are stated to be very low.

A field mounting has been produced for this gun.

Status: Production as required. In service (vehicle and towed versions) with Belgian Gendarmerie, Cameroon, Gabon, Haiti, Indonesia, Malaysia (130 guns), Portugal, Saudi Arabia (39 fitted to Cadillac Gage V-150), and Singapore (40). The vehicles involved include the Chaimite V-400 (4×4), Commando V-150 (4×4) and the Dragoon 300 (4×4).



MECAR 90/28 90 mm light gun

Manufacturer: MECAR SA, B-7181 Petit-Roeulx-lez-Nivelles, Belgium. Telephone: (32) 67/21 77 95 Telex: 574 38 Fax: (32) 67/21 63 07

SPECIFICATIONS CALIBRE LENGTH	90 mm	RATE OF FIRE	10 rds/min	HE MUZZLE VELOCITY	6500 m
overall	3130 mm	sustained	7 rds/min	HEAT	633 m/s
barrel	2900 mm	MAX RANGE		HE	338 m/s
WEIGHT (total)	274 kg	effective, HEAT	1000 m	smoke	338 m/s
LENGTH OF RECOIL	400 mm	HEAT	3500 m	cannister	338 m/s
RIFLING	112 grooves, right hand 1°	combat, HE	4200 m		

MECAR Improvement Programme for 90 mm Cockerill Mk III and 90 mm ENGESA EC-90 guns

Development/Description

For some years MECAR has been producing ammunition for the 90 mm Cockerill and ENGESA EC-90 90 mm guns that are installed in a number of tracked and wheeled light armoured vehicles.

Some of the limitations of these 90 mm gun systems are their relatively short anti-armour effective combat range and their inability to engage and defeat medium armour at high angles of obliquity or spaced armour of more modern light armoured vehicle types using current HEAT and KE rounds, and the inability to fire KE APFSDS with a long rod penetrator for the existing weapons.

As a private venture, MECAR undertook a study to make cost-effective improvements to these limitations and to upgrade the effective combat range/armour defeating capability of the 90 mm gun systems.

MECAR has now successfully completed the development, evaluation, acceptance testing and subsequent production of a new design of muzzle brake and a complementary APFSDS-T round called the M652 which can be fired from the existing Cockerill and ENGESA 90 mm light gun systems.

In addition to firing the new APFSDS-T M652 round, the guns can fire the existing series of ammunition when the weapon is fitted with the new MECAR muzzle brake.

The existing triple-baffle muzzle brake is replaced by a new MECAR single baffle muzzle brake and this enables the new M652 APFSDS-T round to be used with its greatly increased armour penetration characteristics.

SPECIFICATIONS

Muzzle brake single baffle 19.5 kg TYPE WEIGHT LENGTH 310 mm **OUTSIDE DIAMETER** 228 mm BAFFLE OPENING ANGLE 2 × 120°

MUZZLE REDUCTION ENERGY

60% 90 mm HEAT-T 90 mm APFSDS-T 70%

Gun changes OVERALL LENGTH (reduction of 164 mm compared to Cockerill triple

3569 mm

OVERALL WEIGHT

(increase of 6 kg compared to

Cockerill triple type)

469 kg

GUN CENTRE OF GRAVITY FORWARD DISPLACEMENT

24 mm

RECOIL FORCE APFSDS-T M652 RECOIL SPEED RECOIL CYLINDER PRESSURE

85% of HEAT-T no change no change

Status: Development complete. In production.

Manufacturer: MECAR SA, B-7181 Petit-Roeulx-lez-Nivelles, Belgium. Telephone: (32) 67/21 77 95 Telex: 574 38 Fax: (32) 67/21 63 07



MECAR improvement programme for 90 mm Cockerill and ENGESA EC-90 light gun systems showing muzzle brake

COMMONWEALTH OF INDEPENDENT STATES

125 mm D-81TM (2A46) Smooth-bore Gun

Description

This smooth-bore gun is now known to have the designation of D-81TM (2A46) but is often referred to as the Rapira (or Rapier) 3. It has no muzzle brake but has a bore evacuator and is fed by an automatic loader using a 24-round carousel system. A light alloy thermal sleeve is usually fitted. Semi-combustible propellant cases are used with this gun and the maximum effective range is in the region of 2000 to 3000 m.

The APFSDS projectile can penetrate over 400 mm of a vertical steel plate at 1000 m. An HE-FRAG projectile has a range of 9400 m. The T-64B/ T-80 MBT is armed with a 125 mm gun that can fire anti-tank guided missile as well as various 125 mm rounds.

In May 1989 Iraq showed a Type 69 MBT that had had its 100 mm gun replaced by the complete gun and automatic loading system of the T-72M1 MBT, but as far as it is known this never entered service with the Iraqi Army.

Status: In production. Installed on T-72 and T-80 MBTs. There is also a towed anti-tank gun using the same ordnance. The T-64 is fitted with the 125 mm 2A26 smooth-bore gun which has a vertical ammunition stowage whereas T-72 and T-80 have a horizontal feed. It is also installed in the Yugloslav version of the T-72, the M-84.

Manufacturer: State factories. It is or has been made under licence in the former Czechoslovakia, India, Iraq, Poland, Romania and Yugoslavia. China and Pakistan have developed a 125 mm smooth-bore gun that may well be related to this weapon.

T-72 MBT which is armed with a 125 mm D-81TM (2A46) smooth-bore gun

120 mm (2A60) Breech-loaded Mortar

Description

The self-propelled airborne howitzer 2S9 is armed with a 120 mm breechloaded mortar that can be used both in the direct and indirect fire roles. In the direct fire support role it can engage targets using its direct-fire sight and HEAT rounds, while in the indirect fire role it can engage targets out to a maximum range of 8800 m.

The turret has a traverse of 35° left and right with elevation from -4° to $+80^\circ$. The turret is armed with a 120 mm breech-loaded mortar designated the 2A60 with a barrel approximately 1.8 m long. The mortar is probably provided with an interrupted-screw breech mechanism and a chamber detent to retain a round in place when the barrel is elevated. Ammunition is fixed and loading is manual, although ramming is automatic.

After the loader has selected a round from a ready rack it is placed in a feed tray. After an electrical button has been pressed a rammer automatically seats the round in the chamber and closes the breech.

The rammer is a pneumatic device operating at a chamber pressure of 150 kg/cm². As the breech opens after firing the rammer bleeds compressed air into the chamber to force firing fumes from the muzzle.

The 120 mm mortar has a rate of fire of 6 to 8 rds/min. The direct fire HEAT projectile is estimated to defeat up to 600 mm of conventional armour. In the indirect fire role the mortar fires high explosive, white phosphorous and smoke rounds. According to former Soviet sources, maximum range of the weapon is around 8000 m.

Mounted below the turret rear is an ammunition loading hatch and mounted on top of the hull at the rear is a device for loading ammunition from the ground directly into the fighting compartment. This allows sustained fire missions to be carried out whilst still retaining onboard ammunition supply.

The 2S9 is used by Air Assault Divisions and was used in combat for the first time in Afghanistan. More recently the 2S9 has been observed to be



120 mm 2S9 self-propelled system which is armed with the 120 mm 2A60 weapon

used by the Naval Infantry and Army Divisions. The 2S23 is a BTR-80 (8 \times 8) APC with the turret of the 2S9 system.

Status: In production. In service.

Manufacturer: State factories.

115 mm U-5TS (2A20) Gun

Description

The 115 mm U-5TS, or 2A20, is a smooth-bore gun firing fin-stabilised projectiles and is installed in the T-62 MBT. It has no muzzle brake but is fitted with a bore evacuator and most installations are equipped with a light alloy thermal sleeve. The manual loading limits the rate of fire to about four or five rds/min but the spent propellant cases are ejected from the turret by a mechanism actuated by the gun recoil. The gun is used with two-plane stabilisation equipment.

The gun is effective out to a range of about 3000 m and the length of the gun tube is 55 calibres/6325 mm. The APFSDS round fired by the U-5TS can penetrate 300 mm of armour set at an angle of 0° at 1000 m.

This has been manufactured by Royal Ordnance Nottingham for the Egyptian Army to replace existing barrels on T-62 MBTs or for fitment to new tanks (see separate entry).

Status: Production as required. Installed in T-62 MBT.

Manufacturer: State factories.



T-62 armed with the 115 mm U-5TS (2A20) smooth-bore gun (US Army/Michael Green)

100 mm D-10 Series Guns

Description

The D-10 series of guns was developed during the Second World War around a 100 mm naval round with the D-10s being first production guns for the SU-100 assault gun in 1944. The first of the D-10 tank gun series was the D-10T, which was fitted to a number of trial vehicles before being fitted into the early models of the T-54. This was followed by a version of the same D-10T but fitted with a bore evacuator, and a new version, known as the D-10TG which was equipped for stabilisation in the vertical plane. Then came the D-10T2S equipped for stabilisation in both vertical and horizontal planes.

None of these versions has muzzle brakes and all have horizontal sliding wedge breech-blocks. The recoil system consists of a hydraulic buffer and a hydropneumatic recuperator. All fire the same fixed ammunition. Thermal sleeves can be fitted. Royal Ordnance Nottingham produces a conversion kit to replace the 100 mm gun of the T-54/T-55 and Type 59 tanks. Details are given in this section under the United Kingdom.

Some T-55 MBTs used by the former Warsaw Pact have been upgraded to the T-55AM2 configuration which includes the installation of a thermal sleeve for the 100 mm gun.

The Chinese produce a copy of the D-10T but their designation for it is not known. Production of the D-10 series tank gun has also been undertaken in the former Czechoslovakia and Poland.



T-55 MBT is armed with a 100 mm D-10T2S gun which is stabilised in both planes (US Army/Michael Green)

SPECIFICATIONS

 CALIBRE
 100 mm

 LENGTH
 5608 mm

 WEIGHT
 1948 kg

 RATE OF FIRE
 4 rds/min

 RANGE
 4 rds/min

max 14 600 m max effective 2000 m approx

Status: Probably still in limited production. D-10T installed on T-54 and Type 59 MBTs, D-10TG installed only on T-54A MBT. D-10T2S installed on T-54B, T-54C, T-55 and T-55A MBTs.

Manufacturer: State factories. Also made in China, the former Czechoslovakia, Iraq, Poland and Romania.

T-55 MBT upgraded to the T-55AM2 configuration which includes a thermal sleeve for the 100 mm gun



73 mm 2A28 Gun

Description

The 73 mm 2A28 is a smooth-bore, low-pressure gun with a short recoil that has been specially designed to suit the requirements of mountings on light armoured vehicles. It fires a special fin-stabilised HEAT round, which is also used by the infantry SPG-9 anti-tank weapon. When fired the projectile has an initial muzzle velocity of about 400 m/s which rises after a period to 665 m/s; this means the projectile may be subject to the influences of high side winds. The usual installations feature an automatic loader which loads the gun when it is elevated to +3°30', limiting the rate of fire to around eight rds/min. The gun barrel has provision for the installation of a Sagger wire-guided ATGW above its junction with the turret mantlet.

SPECIFICATIONS

 CALIBRE
 73 mm

 LENGTH (recoil)
 152 mm

 WEIGHT
 115 kg

 RATE OF FIRE (max)
 7-8 rds/min

 RANGE (max effective)
 1300 m

Status: Production as required. Installed on BMP-1 ICV and BMD-1 airborne combat vehicle.

Manufacturer: State factories.



73 mm 2A28 gun on BMP-1 with Sagger mounted above (Donald Spaulding)

30 mm 2A42 Cannon

Description

This weapon is the main armament of the BMP-2 mechanised infantry fighting vehicle and has a long barrel with a muzzle brake.

The 30 mm 2A42 cannon has a dual feed; one would normally be for HE-T and the other for AP-T rounds, both with a muzzle velocity of 1000 m/s. The gunner can select one of two rates of full automatic fire, low at 200 to 300 rds/min and high at 500 rds/min.

According to the manufacturer, effective range when engaging ground targets such as light armoured vehicles is 1500 m while soft skinned targets can be engaged out to 4000 m. Air targets can be engaged flying at low altitudes of up to 2000 m at subsonic speeds and up to a slant range of 2500 m.

In addition to being installed in a two man turret installed on the BMP-2 MICV, this gun is also installed in the new BMD-2 airborne combat vehicle (one man turret) and BMD-3 airborne combat vehicle. The latter is believed to utilise the complete turret of the BMP-2.

SPECIFICATIONS

RECOIL FORCE

 CALIBRE
 30 mm

 LENGTH OF GUN
 3027 mm

 NUMBER OF RIFLING GROOVES
 16

 RIFLING PITCH
 715.5 mm

 FEED
 dual

 WEIGHT
 gun

 barrel
 38.5 kg

MUZZLE VELOCITY 960 m/s
FIRING remote control from electric trigger and mechanical

40-50 kN



BMP-2 armed with 30 mm 2A42 cannon without roof-mounted ATGW (Michael Jerchel)

POWER SUPPLY 27 V DC GUARANTEED SERVICE LIFE 6000 rounds

Status: In production. Installed in BMP-2.

Manufacturer: State factories. Has also been manufactured under licence in the former Czechoslovakia and India for locally built BMP-2 vehicles.

30 mm 2A72 Automatic Cannon

Development/Description

The 30 mm 2A72 cannon fires the same family of ammunition as the 30 mm 2A42 cannon installed in the BMP-2 but has a significant reduction in the number of parts. The 2A72 has 578 parts whereas the 2A72 has only 349

The only known application of the 2A72 cannon is in the BMP-3 infantry combat vehicle. This is armed with a 100 mm 2A70 gun with a 30 mm 2A72 automatic cannon mounted co-axial to the right and with a 7.62 mm coaxial machine gun mounted to the right of the 30 mm weapon.

Effective range against armoured targets is claimed to be 1500 m while lightly armoured targets can be engaged out to 2000 m and helicopters out to 4000 m. The 30 mm 2A72 cannon fires two types of ammunition, AP-T and HE-I.

SPECIFICATIONS

CALIBRE 30 mm LENGTH OF CANNON 3006 mm NUMBER OF RIFLING GROOVES 16 RIFLING PITCH 715.5 mm FFFD dual RATE OF FIRE (min) 330 rpm WEIGHT 84 kg gun barrel 36 kg RECOIL FORCE 60 kN MUZZLE VELOCITY 960 m/s

remote control from electric FIRING

trigger or manual



Mounted co-axial to the right of the 100 mm gun installed in the BMP-3 ICV is the 30 mm 2A72 automatic cannon

POWER SUPPLY GUARANTEED SERVICE LIFE

27 V DC 6000 rounds

Status: In production for BMP-3 infantry combat vehicle.

Manufacturer: State factories.

30 mm 2A38M Cannon

Development/Description

This 30 mm twin-barrel automatic cannon is installed in the 2S6M Tunguska self-propelled anti-aircraft gun/surface-to-air missile system which is the replacement for the ZSU-23-4 self-propelled anti-aircraft gun system. The 2S6M is armed with two 30 mm 2A38M twin 30 mm cannon and also has eight SA-19 surface-to-air missile systems in the ready to launch position.

The twin 30 mm 2A38M cannon is water cooled and has been designed for operation under all environmental conditions from -50 to +50 degrees C. It has an effective range in the air defence role from 200 to 2000 m in altitude with a maximum slant range of 4000 m.

SPECIFICATIONS

CALIBRE 30 mm LENGTH OF WEAPON 3478 mm NUMBER OF RIFLING **GROOVES** LENGTH OF RECOIL 22 mm RATE OF FIRE MUZZLE VELOCITY 960 m/s WEIGHT (less water) COOLING SYSTEM COOLING FLUID WEIGHT OF WATER not over 28 kg RECOIL FORCE 62 kN CHARGING NUMBER OF SQUIDS

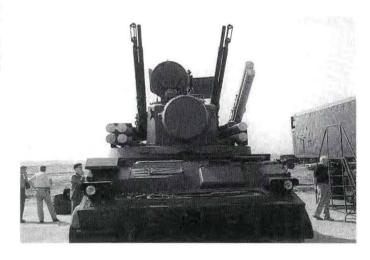
FIRE CONTROL POWER SUPPLY 1950-2500 rpm not over 195 kg evaporative drinking water

pyrotechnic and manual

remote 24 V

Status: In production for 2S6M air defence system used by the Commonwealth of Independent States and India.

Manufacturer: State factories



The 2S6M Tunguska self-propelled anti-aircraft gun/surface-to-air missile system is armed with two twin 30 mm 2A38M cannon and eight SA-19 surface-to-air missiles (Christopher F Foss)

EGYPT

115 mm Tank Gun Barrel

Abu Zaabal Engineering Industries, in co-operation with Royal Ordnance of the United Kingdom, is now offering 115 mm tank barrels for the former Soviet designed and built T-62 MBT. This is essentially a reversed engineered former Soviet U-5TS (2A20) gun using new technology

The original former Soviet method was to manufacture the barrel by shrink fit sleeve/liner; the new method is to use the autofrettage technique. This is claimed to be a simpler, more effective, improved method of production as well as giving a greater barrel fatigue life.

Full details of the barrel are given under the Royal Ordnance 115 mm Tank Gun Barrel in the United Kingdom section. The specifications below are from Egyptian sources.

Note: Abu Zaabal Engineering Industries is also involved in the Royal Ordnance 105 mm T-54/T-55 upgrade package covered under the United Kingdom later in this section, local production of the 122 mm D-30 towed howitzer and the Chinese 130 mm Type 59 field gun and the project to install the 122 mm D-30 into a modified M109/FAASV chassis. A single prototype of the latter has been built by BMY Combat Systems but production has yet to commence.

SPECIFICATIONS

CALIBRE 115 mm

MAX RANGE 3500+ m (indirect fire)
MAX RANGE 4800 m (direct fire)
RATE OF FIRE 4-5 rpm

LENGTH OF PROJECTILE

 TRAVEL
 6.05 m

 MAX ELEVATION
 +12°

 MAX DEPRESSION
 -5°

 TURRET TRAVERSE
 360°

 HEAT MUZZLE VELOCITY
 950 m/s

 APFSDS MUZZLE VELOCITY
 1615 m/s

 HE MUZZLE VELOCITY
 800 m/s

Status: Production as required. In service with the Egyptian Army.

Manufacturer: Abu Zaabal Engineering Industries Company, PO Box 5888 Heliopolis West, Cairo, Arab Republic of Egypt.

Telephone: 2917305/2917033 Telex: 22595 AZED Fax: 2916932/

2917082

FRANCE

Giat Industries 120 mm Smooth-bore Gun G1

Development/Description

Designed by the Etablissement d'Etudes et de Fabrications d'Armament de Bourges, the 120 mm smooth-bore gun G1 has been designed to be interchangeable with the 105 mm CN105F1 tank gun. It uses semi-combustible propellant cases and has been designed to fire both French-produced ammunition and German Rheinmetall-produced ammunition. A vertical sliding breech-block is used. The barrel is chromeplated and autofrettaged. Maximum service chamber pressure is 6300 bars.

The 120 mm smooth-bore gun G1 is fitted to the private venture Giat Industries AMX-40 MBT and the Brazilian ENGESA EE-T1 Osorio MBT, neither of which had entered production as of January 1993.

This weapon has also been referred to as the 120-24 gun.

Variant

In mid-1986 Giat Industries proposed the replacement of the T-62 MBT's 115 mm U-5TS (2A20) smooth-bore gun by the Giat 120 mm smooth-bore gun. In this conversion the original elevation and traverse mechanism is retained, the existing 115 mm ordnance is replaced by the Giat Industries 120 mm smooth-bore gun loading from the right instead of the left and the existing recoil system is modified.

Status: Development complete. Ready for production on receipt of orders.

SPECIFICATIONS

 CALIBRE
 120 mm

 TOTAL LENGTH OF GUN
 7154 mm

 LENGTH OF BARREL
 6200 mm

 NOMINAL RECOIL STROKE
 485 mm

 TOTAL WEIGHT
 2450 kg

 RECOIL WEIGHT
 1830 kg

RECOIL EFFORT AT TRUNNION 27 500 daN (at +51°C) (APFSDS

ammunition)

36 500 daN (at +51°C) (HEAT-MP

ammunition)

OPERATING PRESSURE 4160 bars (APFSDS ammunition)

3150 bars (HEAT-MP

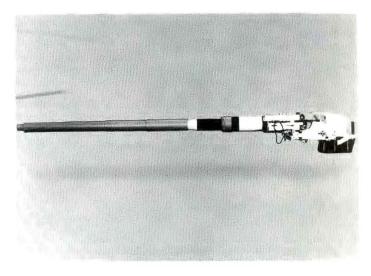
ammunition)

MUZZLE VELOCITY 1650 m/s (APFSDS ammunition) 1100 m/s (HEAT-MP ammunition)

Manufacturer: Etablissement d'Etudes et de Fabrications d'Armement de Bourges (EFAB).

Enquiries to Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex. France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00



Giat Industries 120 mm smooth-bore tank gun G1

Giat Industries 120 mm Smooth-bore Gun F1

Development/Description

The 120 mm smooth-bore gun F1 has been designed for installation in the Giat Industries Leclerc MBT currently in production for the French Army.

The smooth-bore gun is chrome-plated, fitted with a thermal sleeve and has a vertical sliding breech mechanism. It is also fitted with a muzzle reference system and a compressed air system for removing propellant fumes. In the Leclerc application it is fed by a bustle mounted automatic loader, covered later in this volume, which holds 22 rounds of ammunition.

The 120 mm F1 gun fires the same 120 mm ammunition as the German Rheinmetall 120 mm smooth-bore gun installed in the Leopard 2, and its US equivalent the M256, installed in the M1A1 and M1A2 Abrams MBTs.

The French 120 mm F1 gun is, however, 1 m longer, which increases muzzle velocity and armour penetration of APFSDS projectiles; it also gives a longer range.

This weapon has also been referred to as the 120-26 gun.

SPECIFICATIONS

 CALIBRE
 120 mm

 TOTAL LENGTH OF GUN
 6931 mm

 LENGTH OF BARREL
 6200 mm

 NOMINAL RECOIL STROKE
 400 mm

 TOTAL WEIGHT
 2740 kg

 RECOIL WEIGHT
 1995 kg

RECOIL EFFORT AT TRUNNION 55 000 daN (at +51°C) (APFSDS

ammunition)

47 000 daN (at +51° C) (HEAT-MP

ammunition)



Giat Industries 120 mm smooth-bore gun F1 which is installed in the Leclerc MBT

MUZZLE VELOCITY

1790 m/s (APFSDS ammunition) 1100 m/s (HEAT-MP ammunition)

Status: In production. In service with the French Army.

Manufacturer: Etablissement d'Etudes et de Fabrications d'Armement de Bourges (EFAB).

Enquiries to Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

Giat Industries 105 mm CN105F1 Gun

Description

Currently, the French standard MBT gun, the CN105F1, is 56 calibres long and is fitted with a semi-automatic vertical sliding wedge breech-block. No muzzle brake is fitted and a compressed air scavenging system is used instead of a bore excavator. A magnesium alloy thermal sleeve is fitted. The recoil mechanism uses two symmetrically opposed hydraulic brake cylinders with a single hydropneumatic recuperator cylinder. An electrical firing system is fitted.

SPECIFICATIONS

 CALIBRE
 105 mm

 LENGTH
 5900 mm

 barrel
 5900 mm

 recoil
 385 mm

 WEIGHT
 2470 kg

 overall
 2470 kg

 recoiling mass
 1800 kg

 NUMBER OF RIFLING GROOVES
 32

RIFLING INCLINATION 7°10' right hand RANGE (max effective) 5000 m RATE OF FIRE (max) 8 rds/min

Status: In production. Fitted to AMX-30 MBT, AMX-30 B2. A shorter barrel version designated D1504 is fitted to Israeli M51 Shermans, some of which have been sold to Chile.

Manufacturer: Etablissement d'Etudes et de Fabrication d'Armement de Bourges (EFAB).

Enquiries to Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00



AMX-30 B2 MBT fitted with Giat Industries 105 mm CN105F1 gun (Christopher F Foss)

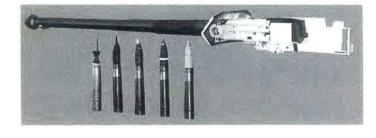
Giat Industries 105 mm 105 G2 Gun

Development/Description

This lightweight long recoil 105 mm rifled gun system has been designed by Giat Industries as a private venture for installation in light tracked and wheeled armoured vehicles and can fire standard 105 mm types of ammunition that are fired by the heavier AMX-30, M60, Leopard 1 and M1 Abrams MBTs.

For trials purposes the 105 mm 105 G2 has been installed in the private venture Giat Industries TGG and TML three man turrets.

The ordnance is fitted with a thermal sleeve, fume extractor and a single baffle muzzle brake.



SPECIFICATIONS

CALIBRE 105 mm

LENGTH 5437 mm

WEIGHT 1610 kg

RECOIL FORCE 1080 kg

RIFLING 28 turns at 9°54' or 32 turns at 7°10'

PRESSURE 5600 bar

MUZZLE VELOCITIES
OFL 105 F1 1500 m/s

OCC 105 F2 (and BSCC) 980 m/s (barrel rifling 7°10' only)

OE 105 G2 690 m/s
OXT 1090 m/s
DISPERSION

 OFL 105 F1
 0.2 mil

 OCC 105 F2
 0.25 mil

 OE 105 F1
 0.25 mil

Status: Prototype. Not yet in production or service.

Manufacturer: Giat Industries, 13 route de la Minière, Satory 78034

Versailles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

Giat Industries 105 mm 105 G2 rifled tank gun

Giat Industries 105 mm 105 G1 Gun

Development/Description

The Giat Industries 105 mm G1 is a further development of the Giat Industries 105 mm CN 105/57 described in the following entry which is installed in the French FL-12 turret of the AMX-13 light tank and the Austrian Steyr-Daimler-Puch SK 105 tank destroyer/light tank.

The modification enables the weapon to fire the 105 mm 105 G1 APFSDS ammunition. This uses the same projectile as that of the 105 mm rounds

fired by the French Giat Industries AMX-30 MBT but uses a smaller cartridge case which gives a different muzzle velocity.

The ordnance is fitted with a single baffle muzzle brake, thermal sleeve, fume extractor and semi-automatic horizontal breech mechanism.

SPECIFICATIONS

BARREL LENGTH RECOIL LENGTH RIFLING

PRESSURE MUZZLE VELOCITIES OCC 105 H2 (HEAT)

OE 105 F1 (HE) OFUM 105 F1 (smoke) OFL 105 G1 (APFSDS) Practice HEAT

800 m/s 700 m/s 695 m/s 1460 m/s 800 m/s

4622 mm

368 mm

2700 bar

32 (right hand) at 9°54'

Status: Production as required.



Giat Industries 105 mm 105 G1 rifled tank gun

Manufacturer: Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex France

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

Giat Industries 105 mm 105/57 Gun

Description

The 105/57 is a lightened version of the CN105F1 developed specifically for export. It uses the same conventional ammunition as the CN105F1 but



Steyr SK 105 tank destroyer with Giat Industries 105 mm 105/57 gun (Austrian Army)

smaller and lighter propellant charges enable it to be fitted into the FL-12 light tank turret. Other changes to the gun include a horizontal breechblock, a muzzle brake, and a single-cylinder recoil mechanism together with a single hydropneumatic recuperator. A thermal barrel jacket can be fitted. The firing mechanism is mechanical.

SPECIFICATIONS

CALIBRE	105 mm
LENGTH	
overall	4622 mm
recoil	368 mm
WEIGHT	
overall	1210 kg
recoiling mass	1065 kg
NUMBER OF RIFLING	
GROOVES	32
DIELING INCLINATION	7º10' right han

7°10' right hand RIFLING INCLINATION

Status: Production as required. Fitted to the AMX-13 with FL-12 turret, the Steyr SK 105 tank destroyer fitted with the FL-12 turret.

Manufacturer: Etablissement d'Etudes et de Fabrications d'Armament de Bourges (EFAB)

Enquiries to Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

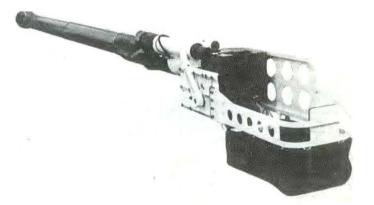
Giat Industries 105 mm F2 (MECA) Gun

Designed as a light gun to fire fin-stabilised projectiles, the 105 mm F2 has a very light barrel with shallow rifling. The semi-automatic breech has a vertical sliding wedge breech-block and electrical firing. Just behind the double-baffle muzzle brake is a fixed muzzle reference mirror to detect barrel warping. A single hydropneumatic cylinder mounted on the left side of the gun acts as the recoil brake. The recuperator cylinder is on the righthand side. More recently Giat has developed an APFSDS round which can be fired by the 105 mm F2 (MECA) gun.

SPECIFICATIONS

CALIBRE	105 mm
LENGTH OF BARREL	5040 mm
LENGTH OF RECOIL	600 mm
WEIGHT	
overall	720 kg
recoiling mass	560 kg
RANGE (max effective, HEAT)	1250 m
CHAMBER PRESSSURE	
(at 20°C)	2100 hars

Status: In production. Fitted only to the AMX-10RC (6×6) reconnaissance vehicle



Giat Industries 105 mm F2 (MECA) gun

Manufacturer: Etablissement d'Etudes et de Fabrications d'Armement et Bourges (EFAB)

Enquiries to Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex, France

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

Giat Industries 90 mm F1 Gun

The 90 mm F1 is also referred to as the CN90F1 and in the past was known as the DEFA D921. It is a light gun, firing fin-stabilised projectiles and is fitted with a double-baffle muzzle brake. The breech is semi-automatic and

fitted with a vertical sliding wedge breech-block. The firing mechanism is mechanical and the recoil mechanism is a single cylinder with a constant stress spring. The recuperator system is hydropneumatic. Low-angled rifling is used in the barrel.

This gun is also produced in South Africa for its Army's Eland 90 and Ratel 90 vehicles. South Africa also produced a towed version based on the British 6-pounder anti-tank gun carriage.

10 WEAPONS OF 20 mm AND UPWARD / France

SPECIFICATIONS

CALIBRE 90 mm

LENGTH
barrel 3000 mm
recoil 580 mm

WEIGHT overall 400 kg

recoiling mass 216 kg

HE and HEAT) 1500 m

Status: In production. Used on AML (4 \times 4) armoured car fitted with Hispano-Suiza H 90 turret; ENGESA EE-9 Mark 11 (6 \times 6) armoured car fitted with Hispano-Suiza H 90 turret; Panhard ERC 90 Lynx (6 \times 6) armoured car fitted with Hispano-Suiza Lynx 90 turret; prototype SIBMAS (6 \times 6) vehicle fitted with Hispano-Suiza Lynx 90 turret; X1A light tank; Eland 90; Ratel 90.

Manufacturers: Etablissement d'Etudes et de Fabrications d'Armement de Bourges (EFAB).

Enquiries to Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex. France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

Lyttelton Engineering Works, 368 Selbourne Avenue, Verwoerdburg 0140, South Africa.



Panhard AML (4 × 4) armoured car fitted with Hispano-Suiza H 90 turret armed with Giat Industries 90 mm F1 gun

Giat Industries 90 mm CN90F3 Gun

Description

The 90 mm CN90F3 was developed primarily to update the main armament of the AMX-13 light tank which was originally fitted with a 75 mm gun. It fires finned projectiles and is fitted with a single-baffle muzzle brake and a thermal sleeve that allows air to circulate between the barrel exterior and the sleeve interior. A horizontal sliding breech-block is employed.

SPECIFICATIONS

CALIBRE 90 mm

LENGTH

less muzzle brake 4590 mm (approx)

recoil 340 mm AVERAGE RECOIL FORCE 2500 kg

Status: Production as required. Fitted to AMX-13 light tank with FL-10 turnet

Manufacturer: Etablissement d'Etudes et de Fabrications d'Armement de Bourges (EFAB).

Enquiries to Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex. France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00



AMX-13 light tank with FL-10 turret with 90 mm Giat Industries CN90F3 gun

Giat Industries 90 mm CS Super (Super 90) Gun

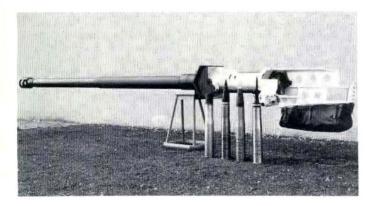
Description

The Super 90 90 mm gun is a development of the earlier 90 mm F1 and F3 series, and is much more efficient, combining low weight with a high muzzle velocity. It fires conventional and 90 mm APESDS projectiles and is much longer than the earlier guns with a barrel length of 52 calibres as opposed to 33. The barrel and breech are manufactured from ESR steel and the vertical-wedge breech is inclined at an angle of 35° to the left to ease loading. The breech mechanism is made up from modular assemblies and the recoil mechanism has been designed so that the sub-assemblies can be removed for maintenance without stripping down the complete gun. A

thermal sleeve is fitted around the barrel. The muzzle brake is a single-baffle design with 30 per cent efficiency. The barrel can withstand internal pressures of up to 2100 bars and the ratio of recoil weight to total weight is 72 per cent. This gun is now referred to by Giat Industries as the 90 mm CS 90 Gun Model F4.

Status: In production. Fitted to Renault VBC 90 (6 × 6) armoured car (TS 90 turret); Panhard ERC 90 Sagaie 1 (6 × 6) armoured car (TS 90 turret); AMX-10 PAC 90 fire support vehicle (TS 90 turret) and SAMM TTB 190 (in service with Gabon on Sagaie 2 armoured car). Early in 1990 the TS 90 turret was installed on the private venture MARS 15 light tank developed by Mecanique Creusot-Loire.

SPECIFICATIONS		GUN PORT WIDTH	470 mm	HE	750 m/s
CALIBRE	90 mm	WEIGHT		long-range HE	700 m/s
LENGTH		inc armour shield	602 kg	smoke	750 m/s
overall	5740 mm	recoil assembly	422 kg	canister	750 m/s
barrel	4680 mm	NUMBER OF RIFLING		MAX EFFECTIVE RANGE	
rifling	4022 mm	GROOVES	60	APFSDS	1700 m
chamber	617 mm	RIFLING INCLINATION	25°	HEAT	1100 m
recoil, nominal	550 mm	MUZZLE VELOCITY		HE	925 m
barrel guide	1200 mm	APFSDS	1275 m/s	long-range HE	6900 m
GUN PORT HEIGHT	380 mm	HEAT	950 m/s	smoke	925 m
				canister	200 m



Manufacturer: Etablissement d'Etudes et de Fabrications d'Armement de Bourges (EFAB)

Enquiries to Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex, France

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

Giat Industries 90 mm Super 90 gun as installed in TS 90 turret

Giat Industries 81 mm Rapid Fire Mortar

Development/Description

As a private venture, Giat Industries has developed a new 81 mm rapid fire mortar which was first revealed in 1988 mounted in a Giat Industries fully enclosed turret. For trials purposes, it was installed on a Giat Industries AMX-10P tracked chassis, although it can also be installed on wheeled chassis such as the VAB.

The mortar consists of a magazine-fed weapon with five rounds of ammunition for ready use. The recoiling parts, including the muzzle brake and return spring, are protected by a cover that is attached to the cradle. The firing pin is re-armed by the recoil and returned to firing position with release controlled by an electromagnet.

Operation is microprocessor controlled and fully automatic. Four modes are available: loading; unloading; burst firing; and single shots. To operate the mortar, the crew has to indicate the mode, drop the bombs into the magazine during the loading cycle, and press the firing button during the firing cycle (single shot or bursts). In the event of non-ignition or delayed firing, re-arming the firing pin is carried out with the special handle.

According to Giat, the mortar's high degree of safety stems from the impossibility of double feed. The weapon is stopped in the event of delayed firing, failed ignition or fume extraction.

The Giat 81 mm rapid fire mortar can fire all current 81 mm mortar ammunition provided that it is no longer than 512 mm, including the Thomson Brandt Armements M61 and M82 and the RAUFOSS NM123 to a maximum range of 6000 m.

The turret can be traversed 30° left and right and the mortar elevated from +38° to +83°, with the mortar being mounted on the right side of the turret and the gunner on the left. The gunner has an optical sight, a raised

cupola with periscopes for all-round observation and a single-piece hatch cover that opens to the rear.

The main advantages claimed for this system by Giat Industries include rapid into and out of action times, no bedding requirement, rapid adjustment of fire due to its automatic fire control, high rate of fire (five mortar bombs can be fired in four seconds), NBC and small arms/fragment protection for

SPECIFICATIONS

CALIBRE	81 mm
LENGTH	2200 mm
TOTAL WEIGHT MORTAR	450 kg
MAX FORCE	3200 daN
POWER SUPPLY	24 V DC
STANDBY CONSUMPTION	1.5 A
MAX CONSUMPTION	75 A
MAX RANGE	6000 m
HEIGHT OF CUPOLA	750 mm
DIAMETER OF RING BEARING	1278 mm
DEPTH OF TURRET	1300 mm
ELEVATION	+38° to +83°
TRAVERSE	30° left and 30° right

Status: Prototype.

Manufacturer: Etablissement d'Etudes et de Fabrications d'Armement de Bourges (EFAB)

Enquiries to Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

Thomson Brandt 81 mm MCB 81 Gun Mortar

Description

The Thomson Brandt MCB 81 gun mortar combines the high-elevation angle fire of the mortar with the low-angle fire of the conventional gun. It is a relatively light weapon suited to turret or ring mountings in light armoured vehicles. For low-angle fire the bomb is loaded at the breech which is a vertical sliding block. Once closed the breech firing mechanism can be either electrical or mechanical. As with most other mortars, the barrel is smooth-bored. The MCB 81 can be fitted with an optional automatic crosslevelling device that can accommodate trunnion angles of ±10°, and a manual levelling system is also available for use in vehicle turrets. The gun can be used at elevation angles of -5 up to +66° and, using a special longrange bomb, it can reach ranges of 8000 m. A special armour-piercing projectile has a maximum effective range of about 1000 m. The recoil system is hydraulic

SPECIFICATIONS

M57D bomb HE

CALIBRE 81 mm LENGTH 3160 mm WEIGHT complete 450 kg recoiling mass 210 kg (approx) MAX EFFECTIVE RANGE

Thomson Brandt 81 mm MCB 81 gun mortar

6000 m
8000 m
5000 m
8000 m
1000 m
100 m
15 rpm

Status: Fitted to Giat Industries AMX-10 TMC 81 81 mm mortar gun carrier. This system is still at the prototype stage.

Manufacturer: Thomson Brandt Armements, 204 Rond-Point du Pont de Sèvres, 92516 Boulogne-Billancourt Cedex, France. Telephone: (1) 46 20 65 65 Telex: 631882 F BRANTAR

Thomson Brandt 60 mm MCB 60 C Gun Mortar

5500 m

Description

This was developed from the HB 60 gun mortar which was first installed in the Panhard AML (4 × 4) armoured car for use in North Africa. The latest version is the MCB 60, although it is also referred to as the MCB 60 C. This Thomson Brandt weapon combines the muzzle loading of the mortar and the breech loading of a conventional gun and can be used as either. As a mortar the firing mechanism is a fixed firing pin, but when used as a gun the mechanism incorporates a vertical falling breech-block with either electrical or mechanical firing. Several safety measures are fitted, including an antidouble loading device in the breech mechanism and a system to ensure the firing pin is safely withdrawn if the breech is not completely closed. The recoil system is hydraulic with a heavy spring recuperator around the barrel which is smooth-bored. Most installations permit elevation angles of -11 to +75°

12 WEAPONS OF 20 mm AND UPWARD / France

SPECIFICATIONS	
CALIBRE	60 mm
LENGTH	
overall	1210 mm
recoil	135 mm
WEIGHT	
complete	82 kg
recoiling mass	42 kg



Thomson Brandt 60 mm MCB 60 C gun mortar shown in full recoil position

RANGE	
standard HE bombs	2240 m
M63 illuminating	2000 m
M72 HE bomb	2650 m
anti-armour	500 m
close defence	50 m
MIN RANGE	
(according to firing mode)	100-300 m
RANGE IN FLAT	
TRAJECTORY	50 up to 600 m
MAX RATE OF FIRE	
drop fire	20 rpm
breech fire	12 rpm
SUSTAINED RATE OF FIRE	12 rpm
MAX ADMISSIBLE BARREL	***************************************
PRESSURE	1300 bar

Status: Production as required. Installed in Hispano-Suiza 60/20 turret; Mecanique Creusot-Loire MCB 60 HB mortar ring shield; Hispano-Suiza HE 60-7 and 60-12 turrets; Thomson Brandt 60 mm armoured turret. By late 1992 production of the Thomson Brandt MCB 60 C gun mortar had amounted to over 500 units.

Manufacturer: Thomson Brandt Armements, 204 Rond-Point du Pont de Sèvres, 92516 Boulogne-Billancourt Cedex, France Telephone: (1) 46 20 65 65 Telex: 631882 F BRANTAR

Thomson Brandt 60 mm MCB 60 LR Gun Mortar

Description

This weapon is similar to the Thomson Brandt 60 mm MCB gun mortar but the barrel is longer to give increased muzzle velocity and therefore range, so the weapon is heavier.

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SPEC	-	L . A I	15.3	\sim

SPECIFICATIONS	
CALIBRE	60 mm
LENGTH	
overall	1920 mm
recoil	174 mm
WEIGHT	
recoiling mass	90 kg
recoil forces	2600 kg
MAX RANGE	
(long-range bomb)	5130 m
MIN RANGE	100 m
EFFECTIVE RANGES	
APFSDS (FLAT	
TRAJECTORY)	1000 m
MAX RATE OF FIRE	
drop fire	18 rpm



Thomson Brandt 60 mm MCB 60 LR gun mortar shown in full recoil position

SUSTAINED RATE OF FIRE	
breech loaded	12 rpm
MAX ADMISSIBLE BARREL	
PRESSURE	2000 bar

Status: Production as required. Installed in Hispano-Suiza Serval 60/20 turret (production) and open mount. By late 1992 production of the Thomson Brandt MCB 60 LR gun mortar amounted to over 20 systems, all of which were for the export market in the Serval 60/20 turret.

Manufacturer: Thomson Brandt Armements, 204 Rond-Point du Pont de Sèvres, 92516 Boulogne-Billancourt Cedex, France Telephone: (1) 46 20 65 65 Telex: 631882 F BRANTAR

Giat 45 mm Case Telescoped Ammunition (CTA) Cannon

Development

In mid-1992, Giat Industries unveiled their new 45 mm Case Telescoped Ammunition (CTA) cannon which has been developed as a private venture. The first 45 mm CTA demonstrator cannon was completed in 1991 with the first prototype being completed the following year.

One of the first applications of this weapon could be the VAD (8 \times 8) member of the VBM family of wheeled vehicles projected for service with the French Army in the 21st Century.

The VAD (Véhicule d'Appui Direct - or Direct Support Vehicle) could be fitted with a two man power operated turret armed with a 45 mm CTA cannon and a co-axial machine gun. The main armament of the VAD is designated the MCF (Moyen Calibre Futur/Future Medium Calibre Gun - FMCG).

The US 45 mm round uses a metallic cartridge case while the French round uses a plastic case. Other differences include firing systems and both weapons have different operating concepts, the US weapon being gas operated while the French weapon is driven by an electric motor.

Late in 1992, Alliant Techsystems of the USA and Giat Industries of France signed an agreement to promote international development of the 45 mm CTA armament system to meet the anticipated NATO future combat vehicle requirement.

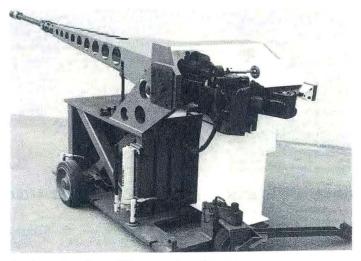
This agreement builds on both companies efforts to develop telescopic ammunition, for example, the Alliant Techsystems COMVAT covered later in this section and the Giat Industries 45 mm CTA.

The agreement signed in 1992 provides for the framework for a more detailed business agreement between the two companies on the 45 mm system. Ammunition development is expected to be carried out by a joint team of Alliant Techsystems/Giat Industries while cannon/feed development

is carried out in Bourges, France by a joint Giat Industries/Alliant Techsystems team.

For trials, the French weapon will fire US ammunition while the US weapon will fire French ammunition.

The 45 mm CTA was preceded by the development 35 mm XT 2000 cannon using the same principle of operation. By mid-1992 this had fired over 850 rounds including 250 rounds in bursts. Fin stabilised projectiles were fired at pressures of up to 5500 bar and muzzle velocities of 1600 m/s.



Giat Industries 45 mm CTA cannon from the rear

Description

The weapon fires telescoped ammunition which is 30 to 50 per cent more compact than conventional ammunition as the projectile is seated in the heart of the propellant change and not in front of it. In addition, the round is also lighter and more economical, as plastics are used in the manufacture of the cartridge.

It is envisaged that at least three types of ammunition will be developed for the CTA: armour-piercing fin stabilised; anti-helicopter sub-calibre projectile; and anti-personnel high explosive with programmable electronic fuzing.

The cylindrical shape of the CTA enables the use of the pushthrough-concept in which the feed of ammunition to the chamber is combined with the expulsion of the previously fired cartridge. The cartridge cases are ejected forwards of the weapon and the long barrel is fitted with a muzzle

SPECIFICATIONS

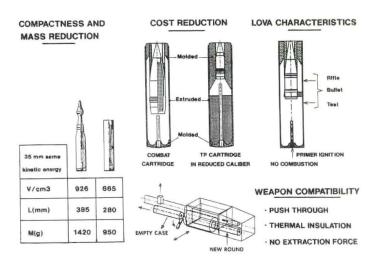
Not released.

Status: Prototype. Not yet in production or service.

Manufacturer: Giat Industries, 13 route de la Minière, Satory 78034

Versailles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00



Main advantages of the Giat Industries 45 mm CTA cannon

Giat 30 mm Industries Model 781 Automatic Gun

Description

First announced at the June 1983 Satory exhibition, the Giat Industries 30 mm Model 781 is an externally powered weapon firing 30 mm ammunition of the 550 family. It is a single feed weapon intended for arming light aircraft, helicopters, armoured and soft-skin vehicles. The mechanism drive and timing is imparted by a cam mechanism and electronic controls are provided to control the rate of fire which may be varied to suit the mounting in use. Single shot, limited or unlimited bursts are possible. The first application for this weapon is the HAP cannon turret installed under the nose of a helicopter, firing Type 30-550 ammunition.

SPECIFICATIONS

CALIBRE 30 mm LENGTH (overall) 1875 mm HEIGHT 310 mm WIDTH 225 mm WEIGHT 65 kg RECOIL FORCE 600 daN RATE OF FIRE up to 750 rds/min



Giat Industries 30 mm Model 781 Automatic Gun

Status: Development.

Manufacturer: Giat Industries, 13 route de la Minière, Satory 78034

Versailles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

Giat Industries 25 mm Model 811 Automatic Gun

Description

The Giat Industries 25 mm Model 811 automatic gun was first shown at the Satory exhibition in June 1983 and has been developed as a private venture for installation in new turrets, such as the Giat Industries Dragar, and for retrofitting in older turrets, such as those armed with 20 mm cannon. It is an externally powered weapon utilising a cam arrangement to time and drive the internal mechanism and it fires standard 25×137 mm ammunition. Ammunition feed may be either dual or single and the rate of fire is variable at 150, 400 or 650 rds/min.

Modes of fire which can be selected using the electronic controls fitted to the gun, are single shot, limited bursts or unlimited bursts. It is possible to start up, operate and service the gun without firing ammunition. The force of recoil is 1500 daN, which makes it suitable for mounting on armoured or unarmoured vehicles. The user can select electric (24 V) or hydraulic drive.

For rate of fire up to 650 rds/min (cyclic), 1.5 kw is required, while 5.5 kw is required for rates of fire up to 650 rds/min. There is no gas intake on the Model 811 as the introduction of rounds, ignition and cartridge case ejection is assured by electrical or hydraulic drive.

According to Giat Industries, the accuracy of the 25 mm Model 811 is such that all rounds will hit a 1.5 m diameter target at a range of 1500 m. Terminal effect of the 25 mm APDS-T round is equivalent at 1500 m to that of a 20 mm round at a range of 1000 m. The explosive mass of the 25 mm

HE round is three times that of a 20 \times 139 mm round. Types of ammunition fired include APDS-T, HEI, HEI-T, SAPHEI, TP and TP-T, which comply with NATO standard STANAG 4173. Turrets that can be fitted with the Giat Industries Model 811 automatic cannon include the Giat Industries Dragar, SAMM TTB 125 and the Mecanique Creusot-Loire T25. In 1987 Giat Industries exhibited the Type 53T4 twin 20 mm automatic anti-aircraft gun with the two 20 mm M693 cannon replaced by a single 25 mm Model 811 cannon

Giat Industries 25 mm Model 811 automatic cannon showing dual-feed



SPECIFICATIONS

CALIBRE 25 mm WEIGHT

gun, cradle, electronic

controls 105 ka electronic controls 8 kg 2630 mm LENGTH (weapon and cradle) WIDTH (weapon and cradle) 340 mm HEIGHT (weapon and cradle) 350 mm RECOIL STRESS 1500 daN RECOIL 25 mm

RATE OF FIRE 150, 400 or 650 rds/min

MUZZLE VELOCITY 1100-1360 m/s

Status: Production. In service with Singapore (Dragar turrets on AMX-10P Marine) and selected by Turkey (515 guns in Dragar turret for installation on locally built AIFV. Of these, 60 will be supplied by Giat, with remainder being built in Turkey by MKEK. Of the 515 turrets, 67 will be supplied by Giat and the remainder built under licence in Turkey).

Manufacturer: Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex, France

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

Giat Industries 20 mm M621 (F1) Cannon

Description

The Canon Mitrailleur de 20 mm modele 621 (CN-MIT 20 M621) fires American 20 mm M56 ammunition which is widely used and manufactured. It is a gas-operated weapon that can fire from locked breech for single shots or at rates of 800 rds/min. The gun uses a flat ammunition feed, usually from the left but variable to suit the installation. Alternatively the rounds can be fed into the gun over the receiver which allows the ammunition links to be fed out from the same side as the side ammunition feed. Further alternatives are flat feed powered by a built-in generator, or a dual-feed system with one feed coming into the gun from each side, allowing two types of ammunition to be selected. Other variations include hand-cocking or arming the gun using an electrical mechanism. An electrical control box enables the firer to select the fire mode (single-shot or either of the two cyclic fire rates, or bursts or safety, all combined with the dual-feed system if fitted), and the control box can also record the number of rounds fired. An automatic re-cocking device can be fitted for use in the event of a misfire.

SPECIFICATIONS	
CALIBRE	20 mm
LENGTH	
gun	2179 mm
recoil	50 mm reverse,
	17 mm forward
WIDTH	203 mm
HEIGHT	194 mm
WIDTH (in cradle)	202 mm
WEIGHT	
gun	45.5 kg
cradle	12.5 kg
RATE OF FIRE (cyclic)	800 rds/min
AVERAGE RECOIL LOAD	250 daN
ELECTRICAL ENERGY	28 V, 10 A



Giat Industries 20 mm M621 (F1) cannon

Status: In production. Installed on AML with SAMM S 530 twin 20 mm turret; Chaimite V-300 with SAMM S 530 twin 20 mm turret (prototype); Panhard ERC with SAMM S 530 twin 20 mm turret (prototype); Panhard M3 VDA twin 20 mm SPAAG; Giat Industries Toucan 1 turret; SAMM TAB 220 twin 20 mm turret; Mecanique Creusot-Loire CB 20 mm mount

Manufacturer: Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex, France

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

Giat Industries 20 mm M693 (F2) Cannon

Description

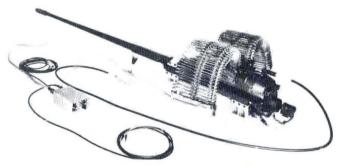
The 20 mm M693 fires Hispano-Suiza HS 820 ammunition and is gas operated. The gas system operates via two gas vents, one on each side of the barrel, through which the propellant gases can push against two gas pistons. The gun is locked by two swinging locking devices which act as struts between the gun body and the gun block. On firing, the two gas pistons are driven to the rear, moving the struts backwards and so allowing the breech-block to move to the rear. In this way all the firing forces are developed along the barrel centre-line to keep accuracy constant.

The M693 has three main assemblies: the basic gun or recoil mass; the cradle; and the fire control unit. The basic gun includes a 7° rifled barrel made of a special nitrided steel and fitted with a muzzle brake. The feed operates on a ratchet and pawl mechanism rotating two side sprockets which can feed ammunition into the gun from both sides, ejecting the spent cases from the same side as the feed in use. This system allows two types of ammunition to be fed into the gun. Firing is electrical using a 24 V DC circuit and the fire mechanism can be selected for single shots, bursts or safe. A further control switch can select the ammunition feed to be used. The linked rounds are fed into the gun from flexible chutes. The AP round can penetrate 20 mm of armour at an angle of 60° at 1000 m.

The M693 can be fitted with an electric recocking device including a system to indicate the end of its operation, or a hydraulic recocking device.

SPECIFICATIONS

SPECIFICATIONS	
CALIBRE	20 mm
LENGTH	
overall	2600 mm
barrel	2065 mm
recoil, approx	60 mm
HEIGHT	
with cradle	260 mm
less cradle	228 mm
WIDTH	204 mm



Giat Industries 20 mm M693 (F2) dual-feed cannon (Giat Industries)

WEIGHT	
complete	80 kg
barrel and muzzle brake	25 kg
cradle	10.5 kg
control box	1.25 kg
RATE OF FIRE (cyclic)	900 rds/min
CURRENT DRAIN	6-7 A

Status: In production. Installed on AMX-30 MBT (coaxial); Panhard M3 VDA (twin-mounting); Ratel 20 IFV; AMX-10P IFV (Toucan II turret); Panhard ERC (Hispano-Suiza Serval 60/20 turret); Panhard AML (Hispano-Suiza Serval 60/20 turret); Giat Industries CAPRE 20 turret (prototype); Giat Industries Toucan I turret; Giat Industries Toucan II turret. Also fitted to Giat Industries Cerbere 20 mm (twin), Tarasque 20 mm (single) towed antiaircraft guns and Type 53T4 20 mm (twin). Also produced in South Africa by LEW for a number of applications including Ratel 20.

Manufacturer: Giat Industries, 13 route de la Minière, Satory 78034 Versailles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

GERMANY

Rheinmetall 140 mm Smooth-bore Gun

Development/Description

Under contract to the BWB, Rheinmetall has built six prototypes of a 140 mm smooth-bore gun and its associated APFSDS-T ammunition for trials purposes.

The first application for this would have been the new German Leopard 3 MBT which has now been cancelled although, as of the summer of 1992. funding for the 140 mm smooth-bore gun and its ammunition was continuing.

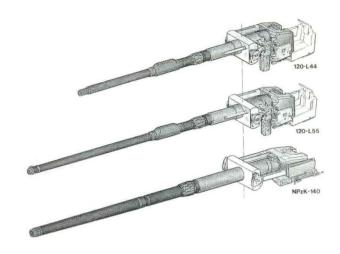
The new 140 mm smooth-bore gun is called the NPzK-140 and is fitted with a vertical sliding breech mechanism, thermal sleeve and a fume extractor

If the threat changed in the future, the German Army would have the option of retrofitting the Rheinmetall 120 mm/55 calibre gun or installing the 140 mm smooth-bore gun. The latter, however, would probably require the installation of a new turret fitted with an automatic loader to handle the separate loading 140 mm ammunition.

Status: Prototype. Not yet in production or service.

Manufacturer: Rheinmetall GmbH, Ulmenstrasse 125, D-4000 Dusseldorf 30, Federal Republic of Germany.

Telephone: (0211) 44701 Telex: 85833-0 Fax: (0211) 483290



Artist's impression of the Rheinmetall 120 mm 44 calibre gun as fitted with the current Leopard 2, the 120 mm 55 calibre gun still at the prototype stage and, bottom, the new 140 mm smooth-bore gun designated the NPzK-140

120 mm Rheinmetall Smooth-bore Gun

Development of the Rheinmetall 120 mm smooth-bore gun began in 1964 although it was not until 1974 that the first hardware trials took place. Series production began in 1979. The gun barrel is a cold drawn tube, with the interior chrome-plated to increase the wear resistance and so lengthen the barrel life. The barrel has a glass-reinforced plastic (grp) fume evacuator 2500 mm behind the muzzle and the thermal sleeve is also made of grp. The breech is secured to the barrel by a threaded bayonet connection and employs a downward-opening semi-automatic sliding wedge block. The breech mechanism incorporates a hydraulically operated loading mechanism which positions the round on the loading chute. When the weapon recoils it is brought back into position by a recuperator. At the same time the breechblock opens automatically. A semi-automatic loading system was developed but the only in-service installations to date (Leopard 2 and M1A1/M1A2) use manual loading for the projectiles and the semi-combustible cases. Firing is electrical. The recoil mechanism comprises two hydraulic retarders and a single hydropneumatic (hydraulic oil/nitrogen) assembly. Types of Rheinmetall developed ammunition that can be fired are HEAT-MP-T, HEAT-MP-TP, APFSDS-T and APFSDS-T-TP, all of which have a partly combustible case with a metal base stub.

Status: In production. Installed in Leopard 2 MBT; M1A1 MBT (first production vehicles delivered 1985) and the M1A2 - the American version, is designated M256. Rheinmetall is now offering the 120 mm smooth-bore gun for retrofitting to other MBTs such as the American M60 series and the Leopard 1. First trials of a Leopard 1A1A1 fitted with a 120 mm Rheinmetall smooth-bore gun were carried out in late 1983 and early in 1985 a Leopard 1 with this gun was successfully demonstrated to current Leopard 1 users; this vehicle also had the EMES-18 fire control system. The Leopard 1 fitted with the 120 mm smooth-bore gun has a total of 42 rounds of 120 mm ammunition: 29 in the hull and 13 in the turret. The Rheinmetall 120 mm smooth-bore gun is also manufactured under licence in Japan for the new Type 90 MBT. Rheinmetall is also developing a 120 mm low recoil concept similar to that of the 105 mm 105 SLR system. This will be suitable for installation on tracked and wheeled vehicles weighing as little as 18 tonnes.

Variant

In mid-1992, Rheinmetall announced that it had developed, as a private venture, a new 120 mm smooth-bore gun with a calibre length of 55 which is a direct replacement for the current 120 mm/44 calibre gun installed in the Leopard 2 used by Germany, Netherlands and Switzerland and in a modified form by Japan and the USA.

The new 120 mm smooth-bore gun is fitted with a thermal sleeve, fume extractor and a muzzle reference system and, in addition to firing the current range of ammunition, will also fire a new range of ammunition with enhanced penetration characteristics.

So far Rheinmetall has developed three generations of APFSDS-T ammunition: the DM13, DM23 and the current production DM33. Almost completed development is the four generation DM43 which has been developed with Giat Industries of France and can also be fired by the Leclerc. This has a penetrator with an increased length-to-diameter ratio.



Leopard 2 (Improved) left and standard production Leopard 2 right both of which are armed with a Rheinmetall 120 mm smooth-bore gun

SPECIFICATIONS (as in L	eopard 2)				
CALIBRE	120 mm	WIDTH		MAX EFFECTIVE	
LENGTH		cradle	728 mm	RANGE (KE)	3500 m
muzzle to spent		recoiling mass	500 mm	BARREL LIFE	700 standard rounds
case box	6168 mm	gun port	730 mm	RECOIL TRAVEL	
total	5621 mm	WEIGHT		normal	340 mm
barrel	5300 mm	gun system, with shield	3655 kg	max	370 mm
trunnion centre-rear		gun system, less shield	3015 kg	MAX RECOIL FORCE	600 kN
breech	1375 mm	gun total	1905 kg	MUZZLE VELOCITIES	
length of cradle bearing	1640 mm	barrel	1175 kg	HEAT-MP-T	1140 m/s
				HEAT-MP-T-TP	1140 m/s
				APFSDS-T-T	1650 m/s
				APFSDS-T-TP	1700 m/s



Manufacturers: Rheinmetall GmbH, Ulmenstrasse 125, D-4000 Düsseldorf 30, Federal Republic of Germany.

Telephone: (0211) 44701 Telex: 85833-0 Fax: (0211) 483290

Watervliet Arsenal, USA. Japan Steel Works, Japan.

Rheinmetall 120 mm smooth-bore gun as installed in Leopard 2 MBT

Diehl 120 mm Mortar System

Development

In 1970, the German Ministry of Defence commissioned Diehl for studies of a 120 mm turret-mounted mortar system which could be aimed, loaded and fired under complete armour and NBC protection.

Diehl subsequently continued to fund these studies under its own initiative which resulted in the definition of a 120 mm mortar turret in 1984.

The first prototype of the 120 mm mortar turret was completed in May 1986 and firing trials with the complete system installed on the prototype of the Krauss-Maffei/Diehl private venture Puma armoured combat vehicle were carried out from June 1986.

Further firing tests took place in Turkey in March 1987 and at the German Army firing range at Meldorf in March 1988.

The German MoD ordered two Puma armoured combat vehicles and the first of these, PM 1, was delivered late in 1989 and is configured as a 120 mm mortar system.

Description

The turret is of all welded steel armour construction with a manual traverse of 45° left and right. The 120 mm mortar is pivoted in the forward part of the turret and can be elevated from +45 to +80°. A total of 20 rounds are carried in the turret with a further 60 rounds in the hull rear.

To enable the 120 mm Diehl mortar to be aimed, loaded and fired under complete armour and NBC protection, Diehl designed the mortar with a split barrel

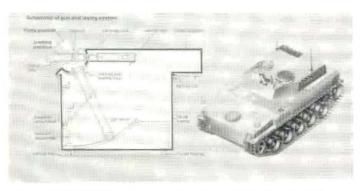
The loader places the mortar bomb with its respective charges onto the loading tray. By operating a lever, the tipped muzzle section is moved into the horizontal position via a gearbox. Using a manual rammer the mortar bomb is pushed through a sufficiently NBC-proof lock and into the tipped barrel

Subsequently, the tipped barrel is swung back into elevation and locked with the main barrel. It is only after the locking operation has been completed that the projectile retaining mechanism in the tipped barrel can be released with an overstroke by operating the same lever.

The mortar bomb then slips into the barrel in a conventional manner, hits the firing pin, which then ignites the propelling charges. The projectile is then fired.

Elevation is achieved by displacing the base anchorage on a sliding rail with elevation and azimuth angles being adjusted by operating mechanical drives from the gunner's station.

The gunner's stabilised roof-mounted sight is mounted to the left of the 120 mm mortar and directly linked to the weapon. For cant angle compensation it can be rotated about the elevation axis on a pin which is coaxial with the barrel. The rotating movements are caused by integrated electronic motors or manually. In the backup mode, the electric motors are activated by a plumb travel pick-up on the persicope via control electronics, so the periscope is always in a vertical position and the line of sight at azimuth zero always indicates the direction of firing. The cant angle is thus automatically compensated with a range of ±5°. It is operated by the commander and used to define the position of the weapon, and for laying when changing targets in the same firing position



Krauss-Maffei/Diehl Puma armoured combat vehicle with schematic of gun and laying system on left and vehicle on right

The automatic cant angle compensation, in conjunction with the reference collimator, considerably reduces mortar laying time in the firing position as well as the time required for target changing.

In the event of failure of the electronic controls, the weapon can be laid manually in the backup mode. The latter is identical with the laying operation for conventional mortars.

The sight has a \times 4 magnification, 10 $^{\circ}$ field-of-view and weighs 12 kg. Maximum rate of fire is up to 16 rds/min and it can fire any future type of mortar bomb with modification. In the future the whole loading sequence

Types of ammunition that can be fired include: TP DM28; HE DM11; illuminating DM26; smoke DM35; HE extended range; cargo with shaped charge bomblets; HE-COFRAM (round improved anti-personnel and light $armour); HE-COFRAM (advanced\ extended\ range\ improved\ fragmentation);$ sensor fuzed anti-armour round; extended range projectile; cargo round; Bussard terminally guided anti-tank; and the Boeing Fibre Optic Mortar Projectile (FOMP) which completed a US Army study contract early in 1989.

Forward Armored Mortar System

To meet any future US Army requirements for a Forward Armored Mortar System, Olin Ordnance of the USA has formed a team consisting of General Dynamics, Land Systems Division (weapon system integration and vehicle design), Magnavox (fire control and navigation), Boeing (fibre optic mortar projectile), Buck (countermeasure smoke), Textron Defense Systems (sensor fuzed munitions), Dynamit Nobel (family of scatterable mines), Western Design Corporation (autoloader) and Diehl/Mauser/Saco Defense (120 mm mortar).

SPECIFICATIONS

could be automated.

CALIBRE 120 mm BARREL LENGTH 1800 mm OPERATIONAL GAS PRESSURE 130 MPa MAX RANGE with DM11 bomb 6500 m MAX RANGE with ER bomb 8000 m AMMUNITION SUPPLY 80 bombs TRAVERSE 45° left and right, manual **ELEVATION** +45° to +80°, manual

Status: Development. Not yet in production or service.

Manufacturer: Diehl Group, Ordnance Division, Fischbachstrasse 16, D-8505 Rothenbach/Pegnitz, Federal Republic of Germany. Telephone: (911) 509 - 1 Telex: 622 591 - 42



Krauss-Maffei/Diehl Puma armoured combat vehicle fitted with turret armed with Diehl 120 mm mortar system

Rheinmetall 120 mm Under Armour Mortar System

Development/Description

The smooth-bore 120 mm under armour mortar has been developed as a private venture by Rheinmetall and can be aimed, loaded and fired under complete armour and NBC protection. It was announced for the first time in late 1990 by which time a single prototype had been built.

Main advantages of this system are: faster into and out of action times; increased rates of fire; and, therefore, reduced susceptability to enemy counter fire.

The system is of modular construction and can be installed on a wide range of armoured vehicles, both tracked and wheeled, with the latter including the widely deployed M113 series of armoured personnel carriers. The latter was chosen for prototype installation and is already the German Army's standard mortar carrier vehicle fitted with a 120 mm conventional mortar.

Main components of the Rheinmetall 120 mm mortar system are the muzzle loaded mortar, recoil system, weapon support, levelling platform and loading manipulator.

The mount and the levelling platform are mounted in the roof of the vehicle with the mortar bombs being fed into the muzzle of the mortar by the loading manipulator which allows a maximum of 18 mortar bombs to be fired a minute. The loading manipulator includes a centre of gravity system and excludes the possibility of double loading.

Elevation limits of the mortar are from +45° to +80° with traverse through a full 360°.

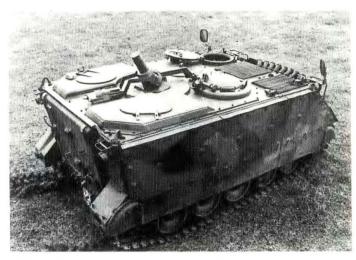
The mortar bomb is initiated by a firing pin in the base of the mortar and a device is provided to prevent double loading of the system. The gunner is provided with a roof-mounted PERI-R16 modified periscopic sight which allows him to lay onto targets under complete armour protection.

In addition to developing the new 120 mm mortar system, Rheinmetall is also developing a new 120 mm mortar bomb called the HE-L which is claimed to be effective against both semi-hard and protected target areas.

The heavy metal fragmenting plate of the mortar bomb allows it to be used against lightly armoured targets such as the tops of armoured personnel carriers. The mortar bomb projectile weighs 12.6 kg and is 595 mm long without its fuze with its maximum design case pressure being about 1500 bar.

Compared with existing 120 mm mortar bombs it has increased volume for explosive content and increased fragment velocity. It can be fitted with a nose-mounted proximity fuze that functions 12 to 15 m above the ground or a base fuze.

The internal and external ballistic properties are said to be identical to the current 120 mm DM11 and DM51 mortar bombs.



M113 series armoured personnel carrier fitted with the private venture Rheinmetall 120 mm under armour mortar system

SPECIFICATIONS

OALIDDE	100
CALIBRE	120 mm
PROJECTILE TRAVEL DISTANCE	1620 mm
WEIGHT	
mortar	550 kg
elevating mass	540 kg
recoiling mass	230 kg
RECOIL DISTANCE	300 mm
MAX BRAKING FORCE	200 kN
ELEVATION RANGE	+45°/+80°
OPERATIONAL GAS PRESSURE	784 bar
FIRING DEVICE	firing pin

Status: Development. Not yet in production or service.

Manufacturer: Rheinmetall GmbH, Ulmenstrasse 125, D-4000 Dusseldorf, Federal Republic of Germany.

Telephone: (0211) 44701 Telex: 85833-0 Fax: (0211) 483290

Rheinmetall 105 mm Tank Gun Family

Description

The basic component of the Rheinmetall 105 mm tank family is the Rh 105-60, a development of the British RO L7 series capable of firing the normal group of 105 mm tank gun ammunition. As with the L7, this gun features a fume evacuator half-way along the barrel and a drop-block breech mechanism.

By careful redesign and balancing, Rheinmetall has produced a modular

family of 105 mm guns capable of being fitted to vehicles as light as 14 tonnes. These guns can all fire normal 105 mm ammunition and are completely compatible with existing fire control systems. The full family, including the Rh 105-60, consists of five guns (the -60 or -40 denotes the recoil force in tonnes). The details are as follows:

SPECIFICATIONS Rh 105-60 Rh 105-40 Rh 105-30 Rh 105-20 Rh 105-11 Model WEIGHT 1380 kg 1320 kg 1360 kg 1340 kg 1380 kg MAX RECOIL FORCE 600 kN 400 kN 300 kN 200 kN 110 kN NORMAL RECOIL 280 mm 400 mm 540 mm 540 mm 925 mm MUZZLE BRAKE **EFFICIENCY** 35% 35% POSSIBLE CHASSIS **APPLICATIONS** M48 Centurion/ M47/Marder 1 M41/AMX-13 Shark/Fuchs

AMX-30

The Rh 105-30 has been fitted to the Spanish M47E2 and is suitable for mounting on the Marder 1. The Rh 105-20 is suitable for mounting on the M41, AMX-13 or Kürassier and is fitted with a muzzle brake.

The Rh 105-11 is also fitted with a muzzle brake and is sometimes known as the 105 SLR (SLR = Super Low Recoil). This gun is being advocated for a variety of light vehicles, possibly using a Rheinmetall autoloading system capable of carrying 15 rounds and firing 10 rds/min. This gun has already been mounted on a MOWAG Shark (8 \times 8) vehicle, Swedish lkv-91 (tested in India), and is also used in the Lightweight Protected Turret Systems developed by Rheinmetall and covered in Jane's Armoured Fighting Vehicle Retrofit Systems 1990-91, page 291. The prototype of the Swedish lkv-91-105 light tank is fitted with the Rheinmetall 105 mm Rh 105-20 SLR gun. In 1987 this weapon was installed in the turret of the French AMX-10RC (6 \times 6) armoured car. Although tested on a number of vehicles, the Rh 105-11 has yet to enter volume production.

SPECIFICATIONS CALIBRE

 CALIBRE
 105 mm

 LENGTH
 6020 mm

 overall
 6020 mm

 gun less muzzle brake
 5620 mm

 barrel less muzzle brake
 5346 mm

 BARREL DIAMETER (max)
 226 mm

 WEIGHT

 Rh 105-11 system
 1800 kg (approx)

 less shield
 760 kg (approx)

 barrel
 760 kg (approx)

 muzzle brake
 50 kg

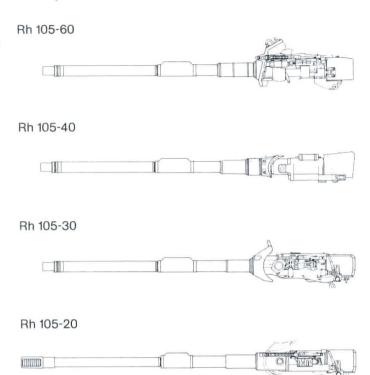
 SERVICE PRESSURE (max)
 5030 bar

 DESIGN PRESSURE (max)
 5200 bar

Status: Development complete. Production as required.

Manufacturer: Rheinmetall GmbH, Ulmenstrasse 125, D-4000 Düsseldorf 30, Federal Republic of Germany.

Telephone: (0211) 44701 Telex: 85833-0 Fax: (0211) 483290



The Rheinmetall 105 mm tank gun family consists of five weapons for different applications

Rheinmetall Automatic Cannon MK 35/50 mm Rh 503

Development

In October 1988 the then West German MoD awarded Rheinmetall a full scale development contract for the MK 35/50 mm cannon.

Prime contractor is Rheinmetall heading a team that includes Heckler & Koch (ammunition transport system), Diehl (HE ammunition development) and Diehl/Mauser (cannon).

Prior to awarding this contract, the now German MoD compared the effectiveness of existing 25 mm, 35 mm and 60 mm calibre weapons against a variety of targets and came to the conclusion that a new weapon was required.

The automatic cannon MK 35/50 mm Rh 503 is required to engage soft and area targets as well as future light armour beyond the year 2000 and to contribute to all-arms air defence, especially attack helicopters, out to a range of 2000 m.

The original application of the Rheinmetall Cannon MK 35/50 Rh 503 was the new Marder 2 infantry combat vehicle. By early 1992 a single prototype of this had been completed by Krauss-Maffei, this being fitted with a two man power operated turret designed by Rheinmetall.

In December 1992, the German MoD announced that development of the Marder 2 was being stopped as part of an economy measure.

The original intention was to develop both 35 and 50 mm versions but development work was subsequently concentrated on the former version due to changing operational requirements. The 50 mm version has however been test fired and could have been backfitted if required in the future if the threat changed.

It was expected that development of the 35 mm cannon and its associated APFSDS-T and HE ammunition would have been completed by 1994 by which time 12 weapons would have been built.

Description

The Rheinmetall MK 35/50 mm Rh 503 is an externally powered weapon that initially fires existing bottle shaped 35 mm ammunition which is already in service with Germany and a number of other NATO countries as well as new Rheinmetall KE and HE rounds.

The 35 mm barrel can, however, be changed in five minutes to allow it to fire new 50 mm ammunition which corresponds to the diameter and length of the 35 mm round case which has been elongated. The new round has no shoulders but instead forms a cylinder from the base of the case to the tip of

the projectile. No other modifications regarding ammunition stowage and feeding are required.

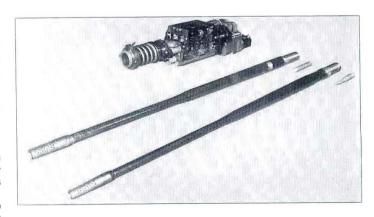
Rh 105-11

As previously stated, the Rh 503 is an externally powered weapon and all functional components are positively controlled which makes the function of the weapon reliable and independent of ammunition gas pressure level.

The rate of fire can be selected to within a range of 150 to 400 rds/min, and single shots can be fired. If the main power supply fails, then drive can be powered by a battery. In addition, manual operation for single shot fire is also available.

The modular design of the weapon (recoiling cannon assembly and drive assembly) keeps service to a low level. The rounds are fed from both sides without links and immediate ammunition change "without a wrong round" is provided. The empty cartridge case is not ejected by a stroke as happens with gas-operated weapons but slides out of the front in a straight line. Therefore, the ports for removing the cases forward out of the turrret have considerably smaller cross sections than conventional automatic cannons. This offers additional design advantages relating to the shield and the arrangement of the weapon in the turret.

In case of ammunition misfire, the cannon is automatically stopped in the safe position by an interlock device. Firing can be continued immediately after the misfired round is ejected.



By means of interchangeable barrels, the Rh 503 can fire traditional bottleshaped 35 mm ammunition and a new cylindrical 50 mm calibre

SPECIFICATIONS		
CALIBRE	35 mm	50 mm
LENGTH	4713 mm	5813 mm
BARREL LENGTH	90 calibre	83 calibre
WIDTH WITH FEEDER	453 mm	453 mm
HEIGHT	320 mm	320 mm
GUN WEIGHT		
total including motor	490 kg	515 kg
barrel	138 kg	163 kg
weapon receiver	229 kg	229 kg
drive unit	123 kg	123 kg
RATE OF FIRE (selectable)	150 to 400 rd	s/min
RECOIL FORCES	20 to 40 Kn	
REQUIRED DRIVE POWER	6-8 kW	
RELIABILITY	5000 MRBF	
SYSTEM SERVICE LIFE	25 000 round	S

In October 1990 it was announced that General Electric Armament Systems had signed an agreement with Rheinmetall under which the MK 35/50 mm Rh 503 automatic cannon and its associated ammunition could be manufactured in the United States.

General Electric will offer the dual calibre Rh 503 to the United States Army for use in future vehicle programmes as well as upgrades to existing vehicles such as the FMC Corporation M2/M3 Bradley IFV/CFV.

Status: Full scale development for German MoD for Marder 2 ICV. Development of this was cancelled late in 1992 so the future of this weapon is now unclear.

Manufacturer: Rheinmetall GmbH, Ulmenstrasse 125, D-4000 Dusseldorf 30, Federal Republic of Germany Telephone: (0211) 44701 Telex: 85833-0 Fax: (0211) 483290

Mauser MK 30 mm × 173 Model F (MK 30) Cannon

Description

The Mauser MK 30 mm × 173 Model F was developed to meet the emerging threats for light air defence and combat vehicle armament systems and is suitable to all applications.

The MK 30 is a fully gas-operated gun in which not only the movement of the bolt but also the ammunition feeding, which is absolutely independent of the bolt movement, are gas pressure operated via a gas-piston. All movable parts, such as return springs, gas piston and buffer are installed along the gun axis to eliminate transverse loads that adversely affect gun motion, thus ensuring an excellent dispersion. The breech system consists of dual locking flaps with a long rigid locking time.

The receiver assembly is forged and its configuration ensures reliability in bad weather. The gun itself is installed in a very simple lightweight cradle in which it can perform recoil movement.

Mechanical simplicity ensures easy maintenance and the gun can be dismantled and reassembled without tools in five minutes

SPECIFICATIONS

SE LOI TOM TIONS	
CALIBRE	30 mm
LENGTH	
with muzzle brake	3350 mm
without muzzle brake	3220 mm
RECOIL	45 mm
AVAILABLE FEEDERS	single-belt, dual-belt,
	dual linkless
HEIGHT	290.9 mm
WIDTH	
single-belt	219.9 mm
dual-belt (inc side	
displacement gun)	364 mm
WEIGHT	
gun complete	
single-belt	148.5 kg
dual-belt	155.7 kg
barrel .	63 kg
feeder	
single-belt	21 kg
dual-belt	28.2 kg
RATE OF FIRE	800 rds/min



Mauser MK 30 mm × 173 Model F cannon with flexible feed chute

RECOIL FORCE max peak 18 kN during bursts 16 kN

Status: In production. Installed in Wildcat twin SPAAG (prototype) and in the German Arrow twin field mount in service with Royal Thai Air Force. Also installed in a twin field mount developed by Hellenic Arms Industry, Greece, under the name of Artemis 30 (but not yet in production). Installed by Breda of Italy in a twin 30 mm field mount Sentinel, a single compact naval mount, and a twin compact naval mount (in service with the Italian Guardia di Finanza). More recently this weapon has been installed in the private venture Austrian Steyr SP3/300 weapon station, fully described in the Turrets and Cupolas section. Single 30 mm local control naval mounting. Installed in the Defence Equipment and Systems DS 30 F naval gun mounting. The Hellenic Arms Industry (EBO) manufactures Mauser MK 30 mm × 173 Model F barrels under licence.

Manufacturer: Mauser-Werke Oberndorf GmbH, Teckstrasse 11, Postfach 1360, D-7238 Obserndorf/Neckar, Federal Republic of Germany. Telephone: 07423 70-1 Telex: 742316-1 Fax: 07423 70-670

Mauser MK 25 mm × 137 Model E Cannon

Description

The Mauser MK 25 mm × 137 Model E gas-operated weapon has been developed as a replacement weapon for the German Marder 1 IFV, currently mounting a 20 mm Rh 202, but for a number of reasons, mainly shortage of funding, this programme is no longer going ahead.



It has the same design and operating principles as the Mauser MK 30 mm × 173 (MK 30).

The Mauser MK fires the standardised 25 mm × 137 ammunition and uses a dual-belt feeder. The gun can be stripped down to its five main components (barrel, receiver, feeder, recoil system, bolt) in about three minutes without special tools.

Status: Development complete and ready for production. Can be fitted in KUKA one and two-man turrets, Norwegian NFT MK 25 Model E field mount anti-aircraft gun system and their APC turrets (for example, M113 and Pbv 302 vehicles) and lightweight navy turrets. SACO Defense Incorporated of the USA has a licence to undertake production of this weapon for the North American market.

Manufacturer: Mauser-Werke Oberndorf GmbH, Teckstrasse 11, Postfach 1360, D-7238 Obserndorf/Neckar, Federal Republic of Germany Telephone: 07423 70-1 Telex: 742316-1 Fax: 07423 70-670

Mauser MK 25 mm x 137 Model E cannon with flexible feed chute

20 WEAPONS OF 20 mm AND UPWARD / Germany-International

SPECIFICATIONS CALIBRE LENGTH	25 mm	WIDTH	309 mm (inc side displacement of feeder)	RECOIL FORCE (max peak) (during bursts)	8.5 kN 7.5 kN
overall	2862 mm	WEIGHT			
barrel without muzz	le	complete	112 kg		
brake	2100 mm	barrel	38 kg		
RECOIL	35 mm	dual-feeder	25 kg		
HEIGHT	268 mm	RATE OF FIRE	900 rds/min		

Rheinmetall 20 mm Automatic Cannon MK 20 Rh 202

Description

The MK 20 Rh 202 has been designed and developed for a variety of applications. It has a high rate of fire but low recoil forces so that it can be adapted to mountings which had not previously been suitable for 20 mm high performance weapons. This gun uses the NATO standard 20 mm \times 139 ammunition with a disintegrating belt.

The gun is gas-operated and has a rigid bolt, which is locked symmetrically by two locking pieces so that all recoil forces are absorbed along a central line. Recoil forces are reduced by a muzzle brake and by firing out of battery. The ammunition feed is gas-operated and does not depend on the movement of the bolt or weapon body.

Two different belt feed mechanisms are available. On the Type 2, two standard belts can be introduced simultaneously from above, and the

Manufacturer: Rheinmetall GmbH, Ulmenstrasse 125, D-4000 Düsseldorf 30, Federal Republic of Germany.

Telephone: (0211) 44701 Telex: 85833-0 Fax: (0211) 483920

operational belt can be selected by a simple lever control. On the Type 3, a single standard belt is used but it can be introduced from above or the left or right without making any mechanical changes.

The gun has been designed to operate reliably under the most arduous physical conditions including temperatures down to -54° C, and including exposure to water and heavy contamination. The Mk 20 Rh 202 can be dismantled and reassembled without using any tools.

Status: Production as required. Installed on FIAT-OTO Melara Type 6616 (4 \times 4) armoured car; Thyssen Henschel Luchs reconnaissance vehicle (8 \times 8), Wiesel airportable vehicle; Marder 1 IFV, Transportpanzer 1 (6 \times 6) (proposal); VCTP (previously VCI) IFV; NM 135 (modified M113 APC) for Norwegian Army; Thyssen Henschel Condor with Rheinmetall TF 20 15 turret; Thyssen Henschel UR-416 with Rheinmetall TF 20 15 turret. The Rh 202 is also widely used as an anti-aircraft gun. The Hellenic Arms Industry (EBO) manufactures Mk 20 Rh 202 barrels under licence; the rifling is carried out on a cold forging machine.



Rheinmetall 20 mm automatic cannon MK 20 Rh 202 disassembled to show main components of weapon

SPECIFICATIONS		WIDTH		RANGE	
CALIBRE	20 mm	Type 2 feed	241 mm	effective	2000 m
LENGTH		Type 3 feed	155 mm	max	7000 m
overall	2612 mm	gun only	110 mm	RECOIL TRAVEL	
barrel less muzzle brake	1840 mm	GUN WEIGHT		reverse	26 mm
rifling	1700 mm	with Type 2 feeder	83 kg	forward	6 mm
HEIGHT		with Type 3 feeder	75 kg	RECOIL FORCES	50-70 kN
Type 2 feed	261 mm	barrel	28 kg	MUZZLE VELOCITY	
Type 3 feed	259 mm	RATE OF FIRE (cyclic)	800-1000 rds/min	HEI-T	1050 m/s
				API-T	1100 m/s
				APDS-T	1150 m/s

INTERNATIONAL

Future NATO 140 mm Tank Gun

Development

Today NATO uses a wide range of tank guns, some of which were developed over 40 years ago. These include the 120 mm smooth-bore gun (Leopard 2 and M1A1/M1A2), 120 mm rifled gun (Chieftain and Challenger 1/Challenger 2), 105 mm rifled gun (M1, M48A5, Leopard 1 and M60 series) and 90 mm rifled guns (M47 and M48).

In mid-1988 it was revealed that five NATO countries had already begun discussions on the development of a new tank gun to replace by the year 2000 the latest 120 mm weapons now in service.

France, Germany, the United Kingdom and the United States are believed to have signed a Memorandum of Understanding to develop a new tank gun for the 1990s. The MoU is involving work on a 140 mm smooth-bore weapon defining such key areas as chamber and breech sizes, rather than defining the complete weapon and its associated mounting system.

The gun would be fitted into future generation MBTs, although it could also be backfitted to existing MBTs.

The United States has already fired a "120 mm lightweight tank gun" which is neither lightweight nor 120 mm (qv this section under USA), and it is known that Royal Ordnance Nottingham has designed and delivered a 140 mm smooth-bore gun to the Defence Research Agency at Fort Halstead. Ammunition for this has been provided by Royal Ordnance Birtley. Watervliet Arsenal is also constructing four prototype 140 mm Advanced Tank Cannon Systems, and additional details of this are given in the United States section.

In May 1990 Giat Industries of France, Rheinmetall of Germany and Royal Ordnance of the United Kingdom, announced that they intended to work together in full co-operation on the next generation of tank main armament including definition, development and, in the longer term, manufacture and commerce.

Because other parties at some future date may wish to become involved in the industrial effort, the agreement between the three companies allows for such additional participation.

ISRAEL

TAAS - Israel Industries 140 mm Smooth-bore

Development/Description

In October 1992 it was revealed that TAAS - Israel Industries (previously Israel Military Industries) had developed to the prototype stage a 140 mm smooth-bore gun and at least one nature of ammunition.

No firm details of the 140 mm smooth-bore gun were provided although it was stated that the first ammunition nature was of the APFSDS-T type.

It is estimated that the APFSDS-T tungsten rod penetrator has a length to diameter ratio of about 25 to one. The three part sabot has a plastic driving band on the rear with the penetrator having eight fins.

The Merkava Mk 1 and 2 are both armed with a 105 mm rifled tank gun while the current production Mk 3 is armed with a 120 mm smooth-bore tank gun (see following entry), all of which are manufactured by TAAS - Israel Industries Ltd.

It is probable that the Merkava Mk 4 will be the first application for this 140 mm smooth-bore gun.

Status: Prototype. Not yet in production or service.

Manufacturer: TAAS - Israel Industries Ltd, POB 1044, Ramat Hasharon 47100, Israel.

Telephone: (3) 5485222 Telex: 33179 Fax: (3) 5406908

TAAS - Israel Industries 120 mm Smooth-bore Tank Gun

Development/Description

This 120 mm smooth-bore tank gun has been developed to meet the requirements of the Israel Defence Forces and was first revealed in 1989 when it was shown to be the main armament of the new Merkava Mk 3 MBT.

This 120 mm smooth-bore gun is similar in principle to the German Rheinmetall 120 mm smooth-bore gun installed in the Leopard 2 and M1A1/M1A2 MBTs, but has a different recoil system and more compact overall dimensions.

The recoil system consists of an optimised concentric retarder and pneumatic recuperator. The envelope dimensions in the turret do not exceed those of the existing 105 mm M68 rifled tank gun, so allowing it to be installed in the narrow silhouette turrets such as the Merkava Mk 3. The gun can, therefore, be installed in other MBTs such as the Merkava Mk 1 and 2, M60, M48 and Centurion with minimal modifications.

The 120 mm ordnance is fitted with a thermal sleeve developed by Vishay in Israel and this is provided with a fume extractor which can be removed for maintenance without disturbing the actual sleeve.

The Israel Military Industries 120 mm smooth-bore tank gun fires a family of ammunition developed by TAAS - Israel Industries but can also fire German or United States 120 mm ammunition if required.

SPECIFICATIONS

 CALIBRE
 120 mm

 WEIGHT WITH MOUNT (Merkava Mk 3)
 3300 kg

 TOTAL LENGTH
 5560 mm

 TOTAL WIDTH
 530 mm

 REQUIRED TURRET APERTURE
 540 × 500 mm



The Merkava Mk 3 MBT has a 120 mm smooth-bore tank gun developed by TAAS - Israel Industries

ELEVATION (relative to the horizon) DESIGN PRESSURE BREECH

7100 bar vertical, sliding wedge

Status: In production. In service with the Israel Defence Forces.

Manufacturer: TAAS - Israel Industries Ltd, POB 1044, Ramat Hasharon 47100, Israel.

Telephone: (3) 5485222 Telex: 33179 Fax: (3) 5406908

Soltam 120 mm Under Armour Mortar

Development/Description

Currently under development by Soltam as a private venture is a 120 mm under armour mortar which will incorporate Soltam's recoil system already developed for its 120 mm mortars. This has already been tested by the US Army during competitive trials after which it was selected for service.

Major features of the Soltam 120 mm under armour mortar are: a range of over 7000 m with extended range ammunition; a range of 10 000 m with rocket assisted ammunition; rapid deployment; rapid under armour loading (automatic and manual); full 360° traverse; elevation from +40° to +85°; option for direct fire mode at 0° elevation; high rate of fire of up to 15 rds/min; and full NBC protection.

The mortar system can be installed on a wide range of chassis, tracked and wheeled, due to the Soltam designed recoil system which reduces the reaction force significantly.

The turret will be of a welded steel construction with two roof hatches being provided in the forward part of the roof.

The enhanced 120 mm ammunition, under a United States Army contract, will have improved fragmentation and lethality features in its HE version. In addition, improved smoke and illumination rounds are being developed.

Status: Under development.

Manufacturer: Soltam Limited, PO Box 1371, Haifa, Israel. Telephone: (4) 89 62 11 Telex: 46277 Fax: (4) 89 40 20

TAAS - Israel Industries 60 mm Hyper-velocity Medium Support Weapon (HVMS 60)

Developmen

Development of the HVMS 60 began as an in-house programme around 1977. Initially it started as a collaboration between the former Israel Military Industries (now TAAS - Israel Industries) for ammunition development with OTO Melara of Italy providing a test barrel and necked-down 76 mm cartridge case, and envisaged a possible joint effort in gun development by Israel Military Industries and turret and automatic loader development by OTO Melara.

However, this joint effort did not materialise and both companies now have their own developed ammunition, gun and applications.

Description

The weapon system is designed primarily for infantry support and can be mounted on relatively light vehicles such as the M113 APC type to increase the firepower available to infantry units.

In addition to being used against armoured vehicles, the HVMS 60 can also be used to engage helicopters and fortified field positions.

The HVMS has an autofrettaged barrel with a fume extractor about half-way along the length of the barrel. The breech mechanism is of the vertical block type, and firing is electrical. A hydrospring recoil system is fitted around the barrel to allow easy barrel replacement in the field without special tools.

The gun is installed in a two man welded steel turret designed by TAAS - Israel Industries with an inner diameter of 1500 mm and a total weight of about 2200 kg.

Several other installations have been developed by replacing the original guns in light tanks, for example the M24, to increase and modernise their firepower. A prototype towed system has also been developed.

Two types of loading system are under development. One version is recoil powered and has two three-round magazines mounted on the gun. This loader allows firing of a three-round burst in three seconds or semi-automatic fire. The other system is hydraulic power assisted.

Status: Early in 1987 production of this weapon had begun for export. installed in a Sherman tank. Chile has installed this weapon in a number of its M24 Chaffee light tanks. In the Sherman application a new mantlet and new ammunition racks are needed. It is not known which of the two loading systems was adopted for the Sherman application, although it could be a manual loading system. The two man turret version has been installed and demonstrated on various existing APCs including the M113 and the Marder 1.

Manufacturer: TAAS - Israel Industries Ltd, POB 1044, Ramat Hasharon 47100, Israel.

Telephone: (3) 5485222 Telex: 33179 Fax: (3) 5406908

Modernised M24 light tank fitted with TAAS - Israel Industries 60 mm Hyper-velocity Medium Support Weapon



SPECIFICATIONS		WIDTH		NUMBER OF RIFLING	
CALIBRE	60 mm	system	500 mm	GROOVES	22
LENGTH		gun	300 mm	MUZZLE VELOCITY	
with auto-load		WEIGHT		(APFSDS-T)	1620 m/s
system	5100 mm	gun	700 kg	RATE OF FIRE	
gun with recoil		recoiling mass	500 kg	auto	100 rds/min
guard	4600 mm	RECOIL FORCE		manual	5-6 rds/min
gun	4300 mm	(trunnion load)	6000 kg		
barrel	4200 mm	RIFLING INCLINATION	1 turn in 30		
recoil	270 mm		calibres, right hand		

MBT G360 20 mm Multi-purpose Light Cannon

Development/Description

The MBT G360 20 mm multi-purpose cannon has been developed by Israel Aircraft Industries, Electronics Division/MBT Weapon Systems, for use in the ground-to-ground, ground-to-air and air-to-ground roles. According to the manufacturer, its low recoil force makes it suitable for mounting on light helicopters, small patrol boats and aircraft.

It operates on the open breech principle and uses standard HSS 804 ammunition which is available worldwide. The ammunition feed can be changed from left to right in the field by the crew.

Firing a burst of 20 rounds during field tests dispersion was only 0.45 mils. The standard HSS 804 AP round will penetrate 34 mm of armour at a range of 1200 m and targets can be effectively engaged at ranges of over 2000 m.

Using standard tools, field maintenance is performed by the gun crew. Safety features include prevention of accidental cook-off, double feeding and commander's override

In addition to replacing 12.7 mm M2 HB machine guns installed on M113 type armoured personnel carriers, it can also replace the 7.62 mm coaxial machine gun installed in tanks, so saving heavier ammunition for tank targets rather than light armoured vehicles.

Status: Prototypes.

Manufacturer: Israel Aircraft Industries, MBT Weapon Systems, Yehud

Industrial Zone 45000, Israel.

Telephone: (972) 3 355221 Telex: 341450 MBT II.

SPECIFICATIONS

CALIBRE 20 mm

RATE OF FIRE controllable from 1 to 600 rds/min

OVERALL LENGTH 2040 mm WIDTH 120 mm HEIGHT 180 mm

WEIGHT OF WEAPON 48 kg including built in BFM and

triggering manual/solenoid

actuator

AMMUNITION TYPE 20 mm × 110

MBT G360 20 mm multi-purpose light cannon installed on an M113 series armoured personnel carrier MUZZLE VELOCITY 1100 m/s TIME OF FLIGHT TO 2000 m APDS round 2.85 AP round 3.85 RECOIL FORCE 204 kg

BARREL GAS PRESSURE 3600 atmospheres BELT PULL FORCE

20 kg



ITALY

OTO Melara 120 Smooth-bore Gun

Development/Description

The OTO Melara/IVECO C1 Ariete MBT, of which six prototypes have been built for the Italian Army, is armed with a 120 mm smooth-bore gun designed by OTO Melara.

As the gun chamber is the same size, it will fire the same ammunition as the 120 mm smooth-bore gun installed in the German Leopard 2 and the United States M1A1/M1A2 Abrams MBTs.

The 44 calibre chrome lined autofrettaged smooth-bore gun is fitted with a muzzle reference system, automatic fume extractor and a thermal sleeve. The coaxial recoil system consists of a recoil buffer and a nitrogen-actuated recuperator, with an internal reservoir installed on the gun cradle

The vertical sliding wedge breech-block remains open after the weapon has recoiled and the stub of the semi-combustible cartridge case has been ejected into a receptacle under the breech.

Prime contractor for the C1's APFSDS and HEAT-MP ammunition is SNIA and a total of 42 rounds are carried, with 15 in the turret bustle and 27 in the hull.

Status: Development complete. Entering production for the C1 MBT that has been ordered for the Italian Army

Manufacturer: OTO Melara, via Valdilocchi 15, 19100 La Spezia, Italy. Telephone: (39 187) 581 111 Telex: 270368 OTO I

Fax: (39 187) 582 669



OTO Melara C1 Ariete MBT which is armed with an OTO Melara 120 smooth-bore aun

OTO Melara 105 Low Recoil Force Gun

Development/Description

The IVECO B1 Centauro (8 × 8) tank destroyer, now in production for the Italian Army, is fitted with a three-man power-operated turret designed and built by OTO Melara, which is armed with a 105 mm low recoil rifled gun.

The long recoil 52 calibre gun is fitted with a thermal sleeve, integral fume extractor, muzzle reference system, a muzzle brake and fires standard 105 mm NATO tank ammunition including APFSDS.

The ordnance is autofrettaged and has a maximum recoil length of 750 mm. It has a vertical sliding breech mechanism that remains open after the weapon is fired and the empty cartridge case is ejected.

Status: In production for the Italian Army. A total of 400 B1 Centauro vehicles have been ordered by the Italian Army with first vehicles being completed in 1991.

Manufacturer: OTO Melara, via Valdilocchi 15, 19100 La Spezia, Italy.

Telephone: (39 187) 581 111 Telex: 270368 OTO I

Fax: (39 187) 582 669



B1 Centauro (8 x 8) tank destroyer which is armed with a long recoil OTO Melara 105 gun

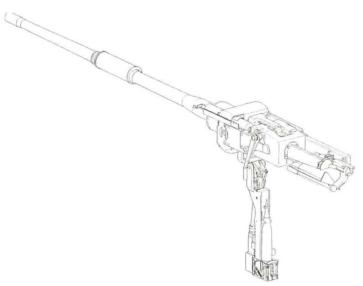
OTO Melara 60 High-velocity Gun System

Development/Description

The 60 mm High-velocity Gun System has been developed as a private venture by OTO Melara and is installed in the OTO T 60/70 two-man turret which is described fully in the Turrets and Cupolas section. This turret can be installed on a wide range of tracked and wheeled vehicles.

The weapon has a 70-calibre autofrettaged ordnance and is fitted with a vertical sliding breech-block and an electrically actuated firing system.

The recoil system is of the hydrospring type and is mounted concentrically to the barrel system, which enables quick replacement of the ordnance in the field with the use of first echelon tools



OTO Melara 60 High-velocity Gun System (not to 1/76th scale)

The weapon is fitted with a twin automatic loading system which makes it possible to load and fire either APFSDS-T or HE rounds at any gun elevation with a rate of one round every two seconds. The APFSDS-T round for the weapon was developed in a joint venture with MECAR of Belgium; the penetrator is provided by HERTEL.

The loading system consists of a twin symmetrical magazine, loading arm, round loading system and a loading control system. The magazine holds 38 rounds and can be loaded from inside the vehicle.

The loading arm receives the selected round (APFSDS-T or HE) from either magazine automatically moving step by step, and carries it in line with the gun barrel where a spring-actuated rammer seats it in the cartridge chamber.

The loading system is hydraulically operated through a built-in hydraulic power unit fitted on the turret basket and is controlled by an electric control system with a minimum number of electrical interlocks. The sequence of operations is controlled by interlocked mechanical devices so reducing the possibility of malfunctions to a minimum.

Status: Prototypes.

Manufacturer: OTO Melara, via Valdilocchi 15, 19100 La Spezia, Italy. Telephone: (39 187) 581 111 Telex: 270368 OTO I Fax: (39 187) 582 669

SPECIFICATIONS

CALIBRE BARREL LENGTH RIFLING

WEIGHT MAX LENGTH OF RECOIL RECOIL FORCE MAX RATE OF FIRE RATES OF FIRE

MUZZLE VELOCITY HE and Practice APFSDS-T

60 mm 4200 mm right-hand, 22 grooves, 1 turn/30 calibres 1000 kg 270 mm 9000 kg 30 rds/min single shots, bursts,

1000 m/s 1630 m/s

full automatic

Breda 40 mm 40L70N Fast Forty Gun

Development

For many years Breda built the Swedish 40 mm L/70 air defence weapon under licence as well as improved versions to meet specific defence requirements.

In 1988 Breda announced that it had developed, as a private venture, the new 40 mm 40L70N Fast Forty gun which fires at the cyclic rate of fire of 450 rds/min, an increase of 50 per cent over the existing gun.

The 40 mm 40L70N Fast Forty gun is included in the modernisation project for the M42 self-propelled air defence turret and for various other tank turret projects.

Description

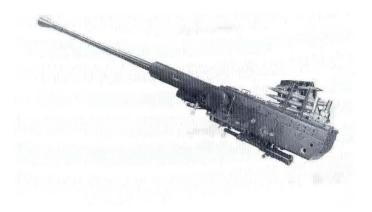
According to Breda, the very substantial increase in the rate of fire is possible because of the intense research and development undertaken by the company, using advanced design techniques such as CAD/CAM through mathematical simulations of the kinematic motions and stresses of the entire mechanism, cold functioning simulations using a specially designed bench with a run out simulator, and in live tests on the firing range.

In designing the Breda 40L70N Fast Forty gun, use has been made of materials such as titanium. The new design entailed a substantial reduction of the distance run by moving components with a consequent time saving. Valuable milliseconds have been gained, for example, by greatly reducing the recoil length. In addition, a new ramming device has been introduced which allows for the transfer of the round from the feeding position to the breech-block closing position, taking a shorter route.

Energy which is made available when firing the gun, is accumulated in hydropneumatic linear motors during the return in battery phase. This gives fast and better controlled breech operation which allows optimisation of the requisite acceleration and deceleration. These devices are employed, for example, for the return in battery of the recoiling mass, for moving the ramming device, to decelerate the round immediately before breech-block closing, accumulating energy employed to render faster the upward movement of the block.

The Breda 40 mm 40L70N continues to fire the standard 40 mm L/70 ammunition types including armour piercing, pre-formed fragmentation (proximity fuzed) and high explosive types.

According to the installation, the gun can be completed with an automatic magazine holding up to 120 rounds of ammunition in two types, so allowing



Recoiling mass of the Breda 40 mm 40L70N Fast Forty gun

the gunner to select a particular type of ammunition to engage a specific target, for example, air or ground.

SPECIFICATIONS

 CALIBRE
 40 mm

 BARREL LENGTH
 2800 mm

 MAX RECOIL LENGTH
 100 mm

 CYCLIC RATE OF FIRE
 450 rds/min

 MUZZLE VELOCITY

 APFSDS projectile
 1350 m/s

 HE projectile
 1025 m/s

Status: Ready for production. Already installed on Breda single/twin naval and field mountings. A turret with anti-aircraft and surface capabilities is currently under development.

Manufacturer: Breda Meccanica Bresciana SpA, Via Lunga 2, 251128 Brescia, Italy.

Telephone: (030) 31911 Telex: 300056 BREDAR I Fax: (030) 322115

SOUTH AFRICA

Armscor 105 mm Tank Gun (GT 3)

Description

This gun has been produced as part of the modernisation of the South African Army's Centurion MBTs to Olifant (Elephant) standard. As the original South African Centurions used 20-pounder tank guns these have been used as the basis for the modernisation. The 20-pounder breech assemblies have been retained and these have been equipped with new mounting lugs for fitting to the existing recoil system. The barrel is a direct copy of the British RO L7 barrel and differs in few respects. The resultant weapon can fire all existing L7/M68 ammunition. Upgrading of the 105 mm tank gun is undertaken at Lyttelton Engineering Works where production is also undertaken of the French 90 mm Giat Industries F1 gun and the 155 mm ordnance of the G5 and G6 artillery systems.

Status: Production. In service with the South African Army. Installed in Olifant Mk 1A and 1B upgraded MBTs.

Manufacturer: LIW, A Division of Denel (Pty) Ltd., 368 Selbourne Avenue, Verwoerdburg 0140, South Africa.

Enquiries to Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635



South African 105 mm tank gun on Olifant MBT

Armscor 76 mm Gun (GT 4)

Development/Description

This 76 mm gun, designated the GT 4, was developed by LIW as the main armament of the Rooikat (8×8) armoured car, first production examples of which were delivered to the South African Armoured Corps in 1989.

The 76 mm/62 calibre gun retains the same chamber volume as the Italian OTO Melara 76 mm Compact naval gun but fires different ammunition, developed in South Africa, in keeping with its role.

The 76 mm gun was chosen for the Rooikat for a number of reasons including: the larger number of rounds capable of being carried when

compared to the 105 mm gun; the ease of handling ammunition moving across country; and the optimum selection of recoil forces and firing impulses for maximum crew operational effectiveness.

The 76 mm gun has a vertical sliding semi-automatic breech mechanism and is fitted with a thermal sleeve and concentric fibreglass fume extractor. The recoil system consists of a concentric hydrospring with external replenisher, with maximum recoil being 370 mm.

Two types of ammunition have been developed for use with this gun: HE-T and APFSDS-T, with the latter having an effective range of 2000 m.

The ammunition of the naval gun can also be fired by replacing the mechanical primer by an electric primer.

 CALIBRE
 76 mm

 LENGTH
 4712 mm

BREECH MECHANISM vertical sliding block, semi-

automatic

RECOIL concentric hydrospring with

external replenisher

MAX RECOIL 350 mm RATE OF FIRE 6 rpm

Status: In production. In service with the South African Army in the Rooikat (8×8) armoured car.

Manufacturer: LIW, A Division of Denel (Pty) Ltd., 368 Selbourne Avenue, Verwoerdburg 0140, South Africa.

Enquiries to Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635

The Rooikat armoured car is armed with a 76 mm GT 4 gun (Christopher F Foss)



Armscor 35 mm GA 35 Automatic Cannon

Development

The 35 mm GA 35 cannon was originally designed by LIW, then part of the ARMSCOR Group and now part of the Denel Group, for the ZA-35 twin 35 mm self-propelled anti-aircraft gun system. This is based on a modified Rooikat (8×8) armoured car chassis which has been developed to meet the requirements of the South African Army, with the prime contractor being Kentron. The turret of the ZA-35 has also been installed on a T-72 MBT chassis for trials purposes.

Since then it has also been fitted to the new LIW eGLas 35 single 35 mm towed anti-aircraft gun system, the first prototype of which was completed in 1992 and it has also been proposed for installation on armoured fighting vehicles such as the Rooikat 35 mechanised cavalry vehicle.

By early 1993, a number of prototype 35 mm GA 35 cannon had been completed and were undergoing extensive trials.

Description

The 35 mm GA 35 cannon utilises gas operation for both feed and bolt mechanisms and can be supplied with single or dual feed. It has a heavy barrel fitted with a perforated muzzle brake and fires standard Oerlikon-Contraves 35 \times 228 mm ammunition including HEI, HEI-T, SAPHEI, API-T, PRAC and PRAC-T types.

The GA 35 is a positively locked breech mechanism with the receiver being of solid construction. The open breech mechanism serves as an important safety feature as it eliminates the danger of the self-ignition (cook-off) of ammunition between bursts.

When integrated with a gun controller, the cannon can be selected to fire single shot or pre-programmed bursts which makes the cannon well suited for aerial, as well as ground applications.

The linked ammunition is fed by either a single or double feeder system via flexible or fixed ammunition chutes with the latter being customised for the various applications of the weapon.

Compared to existing cannons of this type the GA 35 is claimed to be very reliable and have a low life cycle cost due to minimal maintenance requirements. No special tools are required for maintenance and the complete cannon only has some 200 parts.

45 kg

23 kg

SPECIFICATIONS

single feeder

recoil mechanism

CALIBRE 35 mm TOTAL LENGTH 4346 mm BARREL LENGTH 3150 mm (without muzzle brake) BARREL PROTRUSION 2824 mm (with muzzle brake) BARREL INTO RECEIVER 505 mm RECEIVER LENGTH WITH BUFFER 1522 mm MUZZLE VELOCITY 1175 m/s WEIGHT complete gun 429 kg 148 kg barrel

RATE OF FIRE (cyclic) 500-600 rpm

EFFECTIVE RANGE 4000 m

RECOIL

max 27 kN

after first round 18 kN
ACCURACY
single shot 0.6 mrad
burst fire 1.0 mrad

Status: Prototype weapons being used in trials programmes. Not yet in production or service.

Manufacturer: LIW, A Division of Denel (Pty) Ltd., 368 Selbourne Avenue, Verwoerdburg 0140, South Africa.

Enquiries to Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635



The ZA-35 twin 35 mm self-propelled anti-aircraft gun system is armed with GA 35 cannon

Armscor 20 mm G12 Automatic Cannon

Description

This is installed in the Ratel 20 infantry fighting vehicle and may be a locally made version of the French Giat Industries 20 mm M693 (F2) cannon.

SPECIFICATIONS

CALIBRE 20 mm LENGTH OVERALL 2695 mm LENGTH OF BARREL 1860 mm LENGTH WITHOUT BARREL 835 mm WIDTH OF WEAPON 206 mm HEIGHT OF WEAPON 267 mm WEIGHT 73.5 kg RATE OF FIRE 700-750 rpm MUZZLE VELOCITY 1050 m/s (±10 m/s) RECOIL DISTANCE OF WEAPON 35 to 40 mm RECOIL FORCE 4500 N

Status: In production. In service with South African Defence Forces.

Manufacturer: LIW, A Division of Denel (Pty) Ltd., 368 Selbourne Avenue, Verwoerdburg 0140, South Africa.

Enquiries to Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635



Armscor 20 mm GI2 dual feed automatic cannon

Armscor 20 mm GA1 Automatic Cannon

Development/Description

The 20 mm GA1 automatic cannon is an improved version of the 20 mm MG 151 20 mm automatic cannon and is suitable for installation on aircraft, helicopters, light vehicles and armoured fighting vehicles including infantry fighting vehicles.

The 20 mm GA1 automatic cannon has a very low recoil force which, according to Armscor, together with its external geometry, makes it very suitable for installation on hand-held or automatic mountings. It can easily be adapted for left or right hand feed and is recoil operated, firing from the open bolt position.

The low recoil advantage stems from the relatively light cartridge. The original 20×82 mm Mauser cartridge carried a 115 g projectile with a

muzzle velocity of 705 m/s. The new cartridge, produced by Pretoria Metal Pressings, is referred to as a 20×83.5 mm; the case has had the shoulder shortened and the neck lengthened to give better support to the projectile.

The overall length of the complete round remains the same at 146.5 mm. The 20×83.5 mm round has a 110 g projectile with a muzzle velocity of 720 m/s. HEI, HEI-T, SAPHEI, TP and TP-T rounds are available for this weapon.

The HEI and HEI-T are nose fuzed while the SAPHEI is based fuzed. All fuzes have an arming delay and the SAPHEI projectile can penetrate 15 mm of armour plate at a range of 100 m.

Status: In production. In service with the South African Defence Forces.

Manufacturer: LIW, A Division of Denel (Pty) Ltd., 368 Selbourne Avenue, Verwoerdburg 0140, South Africa.

Enquiries to Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635

SPECIFICATIONS

CALIBRE 20 mm LENGTH OVERALL 1770 mm LENGTH OF BARREL 1102 mm LENGTH WITHOUT BARREL 900 mm WIDTH OF WEAPON 240 mm HEIGHT OF WEAPON 195 mm WEIGHT 39 kg 600 to 700 rpm RATE OF FIRE MUZZLE VELOCITY 720 m/s (± 10 m/s) RECOIL DISTANCE OF WEAPON 15 to 30 mm

WEAPON 15 to 30 mi ,RECOIL FORCE 4000 N

Armscor 20 mm GA1 low recoil cannon in helicopter type mount

SPAIN

SANTA BARBARA 40 mm SB40 LAG Automatic Grenade Launcher

Development

The SB40 LAG automatic grenade launcher has been developed as a private venture by SANTA BARBARA for infantry applications, where it is normally mounted on a tripod and for installation in armoured fighting vehicles, trucks, coastal craft and helicopters.

The SB40 LAG automatic grenade launcher has now completed development and in 1992 the Spanish Army took delivery of a pre-production batch of 60 weapons for extensive user trials.

Description

It is an automatic belt-fed weapon that uses 40 \times 53 SR ammunition with a cyclic rate of fire of 200 rds/min and an effective range of 1500 m.

The operating principle is based on a long recoil system which, according to SANTA BARBARA, makes the weapon more versatile by reducing both its weight and effort required to set it up.

The weapon comprises seven key parts, main body, breech, rear block, firing mechanism, recuperating shock absorber, cover and feeding chute.

It can be fed from either right or left side simply by changing the position of certain pieces.

The firing system is mechanical and may be operated manually or from a distance by means of an electric remote-control system.

The aiming system is also mechanical and may be adjusted vertically as well as laterally. Night vision equipment or an optical visor may be mounted on the weapon if required.

The weapon fires two types of 40 × 53R high velocity grenade developed by SANTA BARBARA and brief details of these are given below, in addition it will fire standard 40 mm grenades.

Туре	TP	HE
TOTAL WEIGHT	350 g	350 g
PROJECTILE WEIGHT	240 g	240 g
CARTRIDGE CASE	semi-flange alu	minium alloy
EXPLOSIVE CHARGE	nil	54 g
FIRING MECHANISM	nil	percussion
LETHAL RADIUS	nil	12.5 m

SPECIFICATIONS	
CALIBRE	40 mm
SYSTEM OF OPERATION	long recoil
FEED DEVICE	linked ammunition in belts of 25 or 50 rds
FEED	left or right
FIRING MODE	automatic
WEIGHT	
armament	30 kg
tripod	22 kg
cradle	10.5 kg
box of 25 rounds	10.4 kg
LENGTH	980 mm
WIDTH	200 mm
HEIGHT	220 mm
BARREL LENGTH	415 mm
MUZZLE VELOCITY	240 m/s
MAX RANGE	2200 m

1500 m



Panhard AML (4×4) light armoured car fitted with SANTA BARBARA 40 mm SB40 LAG automatic grenade launcher

Status: Development complete. First pre-production weapons delivered to Spanish Army in 1992.

Manufacturer: SANTA BARBARA SA, Julian Camarillo 32, 28037 Madrid,

Telephone: (91) 58 50 100 Telex: (91) 44466 ENSAB E Fax: (91) 58 50 268

SWEDEN

Bofors 40 mm 40/70B Gun

Development

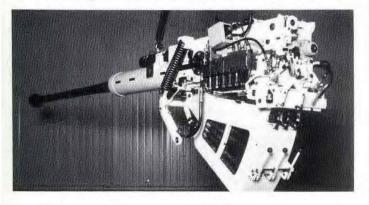
EFFECTIVE RANGE

The 40 mm 40/70B gun has been developed by Bofors as the main armament for some members of the Swedish Army's new Combat Vehicle 90 armoured vehicle, the first production contract for which was placed early in 1991. First production vehicles are expected to be delivered to the Swedish Army in October 1993.

Variants of the Combat Vehicle 90 to be armed with the 40 mm 40/70B gun are the Mechanised Infantry Combat Vehicle (CV 90 40) and the antiaircraft (CV 90 AA). In both cases the weapon will be mounted in a two man turret designed and built by Bofors. Additional details of the turret are given in the Turrets and Cupolas section.

Description

The Bofors 40 mm 40/70B is based on the ordnance of the 40 mm L/70



towed anti-aircraft gun which is loaded with clips of four rounds of ammunition from above with the empty cartridge cases ejected via a chute in the forward part of the weapon.

The 40 mm 40/70B is inverted with the fixed ammunition fed from the bottom and the cartridge cases ejected upwards through a hatch in the turret roof.

Under the breech is the magazine which is divided into three eight-round compartments. Each compartment is loaded with one type of ammunition. The change from one compartment to another is by a hydraulic device: changeover time is two to four seconds. Ammunition is loaded into each of three magazines manually and it takes 60 seconds to load 24 rounds.

The Bofors 40 mm 40/70B gun can fire single shots, two, four or eightround bursts or full automatic. It can fire the following types of ammunition: APFSDS-T with a m/v of 1470 m/s, 3P (pre-fragmented programmable proximity fuzed) with a m/v of 1012 m/s, PFHE Mk 2 (pre-fragmented high explosive proximity fuzed) with a m/v of 1025 m/s and MPT (multi-purpose tracer) with a m/v of 1025 m/s.

Status: In production for the Swedish Army's Combat Vehicle 90.

Manufacturer: Bofors AB, S-691 80 Karlskoga, Sweden. Telephone: (46) 586 810 00 Telex: 73210 Fax: (46) 586 581 45

Bofors 40 mm 40/70B gun showing magazine under rear of breech

SPECIFICATIONS CALIBRE WEIGHT	40 mm	RATE OF FIRE cyclic single shot	300 rds/min 60 rds/min	HEIGHT ABOVE TRUNNIONS DEPTH BELOW	170 mm
gun and magazine gun, magazine and	640 kg	LENGTH forward of trunnions	3315 mm	TRUNNIONS RANGE	770 mm
24 rounds	700 kg	rear of trunnions OVERALL WIDTH	710 mm 450 mm	armoured vehicles attack helicopters	1500-2000 m 3500-4000 m

SWITZERLAND

140 mm Tank Gun

Development/Description

Late in 1991 the Swiss Federal Armament Works stated that it had developed a new 140 mm smooth-bore tank gun to the prototype stage, as a private

For trials purposes this has been fitted into a Leopard 2 MBT of the Swiss Army which has also been fitted with additional armour for improved battlefield survivability

No firm details of the weapon are available although according to Swiss sources the weapon is a scaled-up version of the 120 mm Compact Tank Gun covered in the following entry.

Status: Prototype.

Manufacturer: Swiss Federal Armament Works, Allmendstrasse 86, CH-3602 Thun, Switzerland.

Telephone: (033) 28 11 11 Telex: 921 256 Fax: (033) 28 20 47

120 mm Compact Tank Gun (Smooth-bore)

Development/Description

The incentive to design a lightweight 120 mm smooth-bore gun evolved from the need to retrofit the Swiss Army Pz 68 MBTs at present armed with a 105 mm rifled gun with RO L7 ballistics.

The available 120 mm guns would not fit into the relatively small Pz 68 turret, no extensive turret modifications were allowed and a moderate trunnion load was required. For interoperability reasons the 120 mm gun was required to fire the same ammunition as the Swiss Leopard 2 MBT.

To meet this requirement the 120 mm Compact Tank Gun (CTG) was designed by the Swiss Federal Armament Works (SFAW) at Thun.

To keep the dimensions as small as possible a high strength steel was

used with a 1300 Nmm² yield strength. This was tested for fracture toughness and machinability before the prototype barrels were manufactured. The 120 mm ordnance has been fitted with a semi-automatic vertically

sliding wedge breech-block with electrical firing. A wedge safety catch protects the semi-combustible cartridge case if this is insufficiently rammed. Two recoil brakes and one recuperator are fitted.

The 120 mm smooth-bore gun of the Leopard 2 is an L/44 whereas the new 120 mm gun is a L/49. The front end of the barrel has a dovetail attachment for fixing a muzzle reference system while the bore evacuator is a filament wound glass fibre composite.

It has been designed to fire current and projected 120 mm smooth-bore rounds and has a barrel fatigue life of 1000 rounds.

Although designed for installation in the Swiss Pz 68, it is suitable for upgrading existing MBTs armed with 105 mm guns.

120 mm compact tank gun (smooth-bore) installed in Pz 68 MBT test turret with additional armour being fitted to the hull and turret for improved battlefield survivability

SDECIEIC ATIONS

nm
mm
mm
mm
nm
nm forward from the
ting mass
kg
kg
N
bar
bar

Status: Development complete. Ready for production. Installed in Pz 68 of Swiss Army for trials purposes

Manufacturer: Swiss Federal Armament Works, Allmendstrasse 86, CH-3602 Thun, Switzerland.

Telephone: (033) 28 11 11 Telex: 921 256 Fax: (033) 28 20 47

Oerlikon-Contraves 35 mm Cannon Type KD Series

Description

Oerlikon-Contraves 35 mm cannon are produced in several versions, the most important of which are the type KDA for anti-aircraft and ground use, the type KDB which is produced primarily for use on the twin anti-aircraft gun type GDF series mountings, the type KDC-01 which is used primarily as a naval twin mounting, the type KDC-002, a part of the modification package NDF-C and also integrated in the Oerlikon-Contraves 35 mm Twin Automatic Anti-aircraft Gun Type GDF-005, and the Type KDE which is a lightened version produced primarily for use with gun turrets for light armoured vehicles. All these various types differ in details and weights. The type of ammunition feed varies according to the type but can be linked, belted or from a hopper.

On the 35 mm KDE, ammunition feed is selectable, from either the left or right side and the time required to change from one type of ammunition to another is less than one second. Oerlikon-Contraves has produced various ammunition feed systems for use with the KDE cannon, in the form of either magazines or automatic ammunition feeders incorporated into the turret.

The KDF 35 mm cannon has been installed in the prototype of the 35 mm Escorter self-propelled anti-aircraft system, although this mobile air defence system is no longer being offered.

In the Oerlikon-Contraves company the K stands for Kanone (Cannon), D stands for Kaliber (calibre) and the A, B, C, E, and F stand for Type.



Oerlikon-Contraves 35 mm KDA automatic cannon



Oerlikon-Contraves 35 mm Type KDE automatic cannon with two ammunition feed magazines, each with 17-round capacity

SPECIFICATIONS					
Туре	KDA	KDB	KDC	KDE	KDF
CALIBRE	35 mm				
LENGTH					
overall	4740 mm	4424 mm	4424 mm	4273 mm	4740 mm
barrel without muzzle					
brake	3150 mm				
HEIGHT (overall)	640 mm	479 mm	479 mm	n/a	464 mm
WIDTH (overall)	356 mm	280 mm	280 mm	424 mm	266 mm
WEIGHT (complete)	695 kg	435 kg	435 kg	510 kg	470/495 kg
RATE OF FIRE (cyclic)	550 rds/min	550 rds/min	550 rds/min	200 rds/min	550 rds/min
MUZZLE VELOCITY	1175/	1175/	1175/	1175/	1175/
	1385 m/s				
BARREL LENGTH					
(calibres)	90	90	90	90	90
RECOIL FORCE	25.9 kN	15 kN	15 kN	12 kN	25 kN
MAX RECOIL					
LENGTH	55 mm	60 mm	60 mm	170 mm	55 mm

Status: In production. Installed in twin KDA mounting in the German and Dutch/Belgian self-propelled anti-aircraft gun systems Gepard and Caesar. KDA also installed in British Marconi Radar and Control Systems Marksman turret, which entered production for Finland late in 1988. More recently the KDA 35 mm cannon has been installed in the new Japanese Type 87 twin 35 mm self-propelled anti-aircraft gun system currently in production for the Japanese Ground Self-Defence Force based on a Type 74 MBT chassis.

Type KDE, installed in gun turrets, selected for installation in the Japanese Type 89 MICV.

Twin Type KDB, installed in the GDF-001 and GDF-002 field AA guns.

Manufacturer: Oerlikon-Contraves AG, Schaffhauserstrasse 580, CH-8052 Zurich, Switzerland.

Telephone: (01) 3062211 Telex: 823 402 Fax: (01) 3013466

Oerlikon-Contraves 30 mm Type KCB Cannon

Description

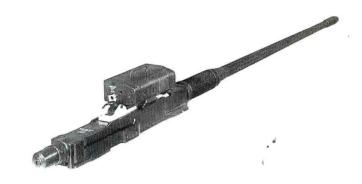
Formerly known as the Type HSS 831, the Type KCB is virtually a scaledup version of the 20 mm Type KAD and has much the same general operating principles. The KCB-B left hand or Type KCB-B right hand, is a gas-operated, belt fed, fully automatic and recoilling cannon. The belt feed mechanism is recoil operated.

Status: Production as required. Installed on Oerlikon-Contraves naval mount GCM family. Emerlec twin 30 naval mount, AMX-30 twin SPAAG; AMX-13 twin SPAAG.

Manufacturer: Oerlikon-Contraves AG, Schaffhauserstrasse 580,

CH-8052 Zurich, Switzerland.

Telephone: (01) 3062211 Telex: 823 402 Fax: (01) 3013466



Oerlikon-Contraves 30 mm Type KCB cannon

SPECIFICATIONS CALIBRE LENGTH	S	30 mm	WEIGHT gun less feed mechanism barrel	138 kg 62 kg	RANGE operational max	3000 m 10 000 m
overall barrel WIDTH (overall)	÷	3524 mm 2555 mm 218 mm	complete RATE OF FIRE (cyclic)	159 kg 600 rds/min	MUZZLE VELOCITY BARREL LENGTH MAX RECOIL REACTION MAX RECOIL	1080 m/s 75 calibres 7 kN 55 mm

Oerlikon-Contraves 25 mm Automatic Cannon Type KBA

Development

The NATO-nominated Oerlikon-Contraves 25 mm automatic cannon Type KBA has been developed as a close-range multi-purpose weapon for the modern battlefield. Due to its firepower, various types of ammunition and its Instant Ammunition Selection Device (IASD), the KBA can engage lightly armoured vehicles, infantry and anti-tank positions, helicopters and combat aircraft.

Description

The Oerlikon-Contraves KBA 25 mm cannon is a fully automatic, positively locked, gas-operated weapon with a rotating bolt head and double belt feed. These features guarantee high reliability and safety, even under the most extreme environmental conditions.

The KBA offers a wide range of firing modes: single shot; programmable rapid single shot with a rate of fire of up to 175 rds/min; and full automatic fire of 600 rds/min. The cannon functions, such as cocking and firing, are electrically actuated by remote-control from the gunner's control box and in auxiliary mode mechanically by a hand crank and a trigger pedal. Types of 25 mm × 137 (NATO) ammunition fired include HEI-T, SAPHEI-T, TP-T, APDS-T and TPDS-T.

For maintenance purposes the cannon can be stripped to its main assemblies without tools.

Small size and low weight offer various integration possibilities such as



Oer likon-Contraves~25~mm~Type~KBA~cannon~with~instantly~selectable~dual~feeder

one- and two-man gun turrets on IFVs, APCs, reconnaissance vehicles and AA-tanks, field, naval and helicopter mounts.

Status: In production. In service with Belgium, Italy, Netherlands, Philippines, selected by Turkey and Japan, also used by other countries. Installed in Oerlikon-Contraves GBD-AOA gun turret on M113 C + R. In FMC EWS on AIFV, four barrel SIDAM 25 OTO Melara anti-aircraft turret on M113A1 for Italy (and for other vehicles such as C13 and VCC 80), OTO Melara T25 turret, Hägglunds Vehicle 25 mm turret, ENGESA 25 mm turret and Breda naval gun mount. In mid-1989 Denmark ordered 50 25 mm KBA cannon from Oerlikon-Contraves of Switzerland which have been fitted into two man OTO Melara turrets and installed on modified M113A2 APCs.

Manufacturer: Oerlikon-Contraves AG, Schaffhauserstrasse 580, CH-8052 Zurich, Switzerland.

Telephone: (01) 3062211 Telex: 823 402 Fax: (01) 3013466

SPECIFICATIONS

CALIBRE 25 mm LENGTH overall 2888 mm barrel with muzzle brake 2173 mm 2000 mm barrel less muzzle brake recoil 25-34 mm HEIGHT (overall) 253 mm

WIDTH (overall) WEIGHT complete barrel RIFLING number of grooves inclination

263 mm 112 kg 38 kg

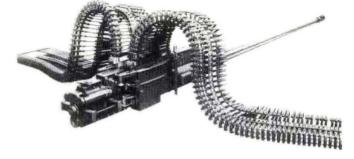
7°30' right hand

RATE OF FIRE (cyclic) 600 rds/min MUZZLE VELOCITY 1150/1335 m/s BARREL LENGTH (calibres) 80 RECOIL FORCE 21 kN MAX RECOIL LENGTH 34 mm

Oerlikon-Contraves 25 mm Type KBB Cannon

Description

The Oerlikon-Contraves 25 mm Type KBB cannon has been developed as a multi-purpose cannon capable of being mounted on a variety of weapon mounts including vehicle mountings. It is a gas-operated weapon with a supporting snaplock and two parallel, common direction ammunition feed mechanisms opposite each other. The required belted ammunition type can be fired by swinging the corresponding feed mechanism into position. The cannon is fixed to the recoil cradle by two removable pins and the ammunition guides are also fixed to the cradle. Thus the cannon body is floating to reduce some of the recoil forces. The rifling system employs the Oerlikon-Contraves progressive twist system. It fires the 25 mm x 181 rounds including HEI, TP, TP-T, APDS-T, TPDS-T and AMDS



Oerlikon-Contraves 25 mm Type KBB cannon with dual feed system

CALIBRE LENGTH overall barrel with muzzle brake barrel less muzzle brake receiver

SPECIFICATIONS

max recoi

3184 mm 2427 mm 2300 mm 1170 mm 34 mm backwards 11 mm forward

25 mm

WIDTH (receiver) HEIGHT (receiver) WEIGHT cannon and barrel barrel

RIFLING number of grooves inclination, end angle 240 mm 225 mm 156 kg (approx)

55 kg (approx)

7°30' right hand

MUZZLE VELOCITY

APDS-T HEI RATE OF FIRE BARREL LENGTH RECOIL FORCE

1285 m/s 1160 m/s 800 rds/min 92 calibres 12.8 kN

Status: Production. Has been fitted on Sea Zenith naval anti-missile defence system. The KBB is also installed in the CMI C 25 two-man, poweroperated turret described in the Turrets and Cupolas section

Manufacturer: Oerlikon-Contraves AG, Schaffhauserstrasse 580. CH-8052 Zurich, Switzerland. Telex: 823 402 Fax: (01) 3013466 Telephone: (01) 3062211

Oerlikon-Contraves 20 mm Type KAA Cannon

Description

Formerly known as the 204 GK, the type KAA is a gas-operated gun with a two part breech having pivoting locks. The firing mechanism uses the 'floating' firing principle in which the gun is fired on the forward moving section of its firing cycle so that the firing forces have to overcome the mass inertia of the forward-moving parts. The ammunition is belt-fed from either side and is powered by the breech by means of an oscillating cylinder which moves the feed pawls. The prominent muzzle brake and barrel are fitted with the Oerlikon-Contraves progressive rifling system in which the rifling pitch alters from 0° at the beginning to 6°30' at the muzzle; the barrel has 12 rifling grooves. The cannon can be field-stripped without tools.

Status: In production. Installed in GAD-AOA turret on Steyr 4K 4FA-G; GAD-AOA turret on MOWAG Piranha (6 × 6) and M113; Helio one-man turret FVT 900 on Condor APC; Cadillac Gage 1 m turret on Commando Scout (prototype); Cadillac Gage two-man turret on V-150 (4 x 4); Cadillac Gage two-man turret on V-300 Commando (6 × 6); Cadillac Gage two-man turret on M113A1 APC (proposal).

Manufacturer: Oerlikon-Contraves AG, Schaffhauserstrasse 580, CH-8052 Zurich, Switzerland.

Telephone: (01) 3062211 Telex: 823 402 Fax: (01) 3013466



Oerlikon-Contraves 20 mm Type KAA cannon

SPECIFICATIONS

CALIBRE LENGTH overall barrel with muzzle brake barrel less muzzle brake HEIGHT (overall)

20 mm 2627 mm 1856 mm 1700 mm 10 mm 241.5 mm

WIDTH (overall) WEIGHT complete barrel RIFLING number of grooves inclination

220 mm 88 kg 26 kg

progressive, 0°-6°30' right hand

RATE OF FIRE (cyclic) MUZZLE VELOCITY BARREL LENGTH MEAN RECOIL FORCE MAX RECOIL LENGTH

1000 rds/min approx 1050/1150 m/s 85 calibres 16.7 kN 10 mm

UNITED KINGDOM

Royal Ordnance Electro Thermal Chemical Guns

Development/Description

In late 1992 it was disclosed that Royal Ordnance had been working, as a private venture, on the development of ETC (Electro Thermal Chemical)

A 10 mm ETC gun, with a 150 kJ power supply, has already fired a projectile weighing 200 g to a maximum muzzle velocity of 1950 m/s.

In mid-1993, Royal Ordnance will commission a new 30 mm ETC gun with a 3 MJ Pulsed Power Supply (PPS) which is expected to be capable of firing a projectile weighing 500 g to a maximum muzzle velocity of 2000 m/s. In the longer term, the PPS will be capable of driving guns up to 105 mm in calibre on a single shot basis.

Future RO ETC gun investment will be concentrated at the former British Manufacture and Research Company (BMARC) facility at Faldingworth in Lincolnshire which was purchased by RO in 1992. This has fully enclosed 200 and 75 m tunnels equipped with instruments capable of capturing events during launch, flight and target interaction.

Royal Ordnance started work on ETC guns in 1990 and until now research has concentrated on building up understanding on how large quantities of electrical power can interact with an enhanced thermochemical pressure

So far RO has invested about £1 million in their ETC gun programme as part of an applied research programme that could lead to a full up weapon system capable of being fielded early in the 21st Century. Initial applications could be artillery and air defence.

The main purpose of the electrical input into an ETC gun is to control the

release of chemical energy. The resulting benefits including a wider range of chemical propellants can be considered and their burn rates be manipulated electrically to achieve maximum ballistic efficiency.

The combination of more energetic propellants at greater efficiencies with an additional injection of electrical energy offers significantly greater performance potential than conventional guns, which are now reaching the end of their growth potential.

The increased flexibility in gun design associated with electrical ballistic control also offers the opportunity for retrofitting, improved systems performance and novel applications, according to Royal Ordnance

Other companies, mainly in the US, have tended to concentrate their research and development work, most of which has been funded by the US Government, in electromagnetic guns. There are two basic types: The Rail Gun and the Linear Induction Accelerator.

More recently, there has been increased emphasis on the ETC as this shows the greatest potential, especially in ground applications, and work has confirmed ETC potential on in-service guns in which only the breech has been modified to accommodate the electrical input.

At present, Royal Ordnance is working on the ETC gun on its own, although the Defence Research Agency, funded by the British MoD, is building an Electro Magnetic Launcher facility at Kirkcudbright in Scotland.

Status: Development.

Manufacturer: Royal Ordnance, Kings Meadow Road, Nottingham NG2 1EQ, United Kingdom.

Telephone: (0602) 863341 Telex: 37531 Fax: (0602) 861436

Royal Ordnance 120 mm L30 Tank Gun

The term '120 mm Modern Technology Gun' has been used to cover a family of high-pressure guns developed over the years to provide the basis for an eventual replacement for the 120 mm L11 series of tank guns. Guns involved in this family include the EXP 14M1, M7 and M13A which were early experimental models. The proposed gun for the cancelled MBT 80 was the EXP 28M1 but it has now been superseded by the XL30, formerly known as the EXP 32M1, with the final development model being known as

In December 1988 it was stated that this gun and its associated ammunition was to enter production for the current Challenger 1 MBT fleet and it is also installed in the prototypes of the Challenger 2 MBT.

In mid-1989 Royal Ordnance delivered the first 50 pre-production 120 mm CHARM (CHallenger ARMament) guns to the British MoD. These are being used for exhaustive reliability trials. The 120 mm CHARM project in fact consists of three components: the Royal Ordnance Nottingham 120 mm gun, the charge and the new APFSDS round, both of which are being developed by Royal Ordnance.

The Modern Technology Guns are all rifled and the latest versions use a form of breech mechanism known as the 'split sliding-block breech' in which the obturation ring (Crossley pad obturation), made necessary by the combustible plastic propellant charges employed, is mounted on a split rising block. This rising block is held in place for firing and a second rising block falls to release the upper one after firing. The two blocks can then fall together for the reloading process. This system combines strength with compactness, and the whole operation sequence can be made semi- or fully automatic.

The gun barrel is a monoblock-construction, swage-autofrettaged Electro-Slag Refined (ESR) steel tube with 1:18 right-hand twist rifling and is chrome plated in the bore and chamber.

The barrel life of the L30 is expected to be of the order of 400 EFC, as RDX in stick form is the propellant used. An integral section near the muzzle will accommodate a muzzle reference sight.

The L30 will fire all current 120 mm projectiles of the current L11 gun with the exception of the APDS. The CHARM 1 projectile has a penetrator of conventional materials while the CHARM 3 projectile has a DU penetrator for enhanced armour penetration characteristics.

One of the nine prototypes of the Vickers Defence Systems Challenger 2 MBTs armed with a Royal Ordnance 120 mm L30 rifled tank gun fitted with thermal sleeve, fume extractor and muzzle reference system

SPECIFICATIONS (L30)

CALIBRE 120 mm LENGTH overall 6863 mm barrel 6604 mm WEIGHT 1775 kg barrel BARREL LIFE 400 EFC

Status: In production. Installed in prototypes of the Challenger 2 MBT and being backfitted into the existing Challenger 1 as replacement for current 120 mm L11. In late 1992 the UK MoD stated that the total cost of the CHARM programme for the Challenger 1 MBT was £262 million and that a total of 381 guns would be built with a projected in service date of 1995.

Manufacturer: Royal Ordnance, Kings Meadow Road, Nottingham NG2 1EQ, United Kingdom.

Telephone: (0602) 863341 Telex: 37531 Fax: (0602) 861436



Royal Ordnance 120 mm L11 Tank Gun

The 120 mm L11 tank gun traces its origins back to the 1950s, and the first firing trials took place during 1961. Breech obturation is obtained by the use of an expanding steel ring on the face of the breech-block. The current service version is the L11A5 used on the Challenger 1 and Chieftain which is manually loaded, although trials have taken place using automatic feed devices, none of which have been produced for service. The 120 mm L11 uses a large vertical sliding breech-block with an integral vent tube magazine for firing the propellant charges. The barrel is a one-piece construction with a bore evacuator two-thirds of the way to the muzzle. Normally, a thermal sleeve is fitted around the barrel. Gun recoil is usually of the order of 370 mm and is controlled by two hydraulic buffers and a hydropneumatic buffer recuperator which dissipate the recoil energy and return the gun to

the run-out position. A semi-automatic cam opens the breech after firing ready for reloading. Recent versions of the L11 have provision for a muzzle reference sight over the muzzle.

Variants

L11A1 Only 130 produced.

L11A2 Numerous improvements introduced, including breech-block interlock and obturator insert indicator. Changes to this version included an actuating shaft stop, changes to the tube vent filling, alterations to the fire channel dimensions, an obturator sleeve protector, the introduction of a 15-vent tube magazine, and an increase in the strength of the breech ring material. L11A3 Projectile stop removed and design changes to the breech ring. L11A4 Not issued.

L11A5 Introduction of forged upstand for Muzzle Reference Sight and a reduced volume and diameter fume extractor of less weight. These two introductions necessitated the fitting of 7.7 kg of weights for balance purposes. This variant includes a semi-automatic plunger fitted to the vent tube loader.

L11A6 Conversion of L11A3 using retrofit shrunk sleeve for Muzzle Reference Sight. New lightweight fume extractor also fitted involving 2 kg of balance weights.

L11A7 Proposed variant of L11A5 with an automatic vent tube loader.



CALIBRE 120 mm LENGTH overall 6858 mm ordnance 6604 mm recoil 370 mm WEIGHT 1778 kg RATE OF FIRE 10 rds/min max normal 6 rds/min



Royal Ordnance 120 mm L11A5 tank gun

RANGE

 max effective, APDS
 3000 m plus

 max effective, HESH
 8000 m

 BARREL LIFE
 120 EFC

Status: Production as required. Installed on Chieftain MBT; Challenger 1 MBT; Khalid MBT.

Manufacturer: Royal Ordnance, Kings Meadow Road, Nottingham NG2

1EQ, United Kingdom.

Telephone: (0602) 863341 Telex: 37531 Fax: (0602) 861436

Royal Ordnance 120 mm Armoured Mortar System

Development

The 120 mm breech-loaded mortar has been developed as a private venture by Royal Ordnance Nottingham since the end of 1985. The first prototype of the mortar, complete with its elevating mass, was completed and test fired in May 1986 before being shown for the first time at the June 1986 British Army Equipment Exhibition.

At that time the 120 mm breech-loaded mortar, which is designated the XN417, was offered in a welded steel armoured turret installed on the RO2003, a member of the RO2000 family of tracked vehicles which also made its first public appearance in June 1986.

During early firing trials the mortar was mounted in a simple turret which in turn was mounted on an FMC M113A2 APC chassis, of which over 77 000 have been built since 1960. All that was required was a simple adaptor over the existing turret ring. When fitted to an M113 vehicle, a total of 66 rounds of 120 mm ammunition would be carried.

In the Autumn of 1991, a Diesel Division, General Motors of Canada, Light Armored Vehicle (LAV) fitted with the turret-mounted Royal Ordnance 120 mm breech loaded mortar, completed a successful series of initial trials at a UK range manned by a British Army crew.

During these trials some 150 rounds of 120 mm Tampella and a new Royal Ordnance 120 mm mortar bomb were fired at high/low ranges in the indirect fire mode as well as in the direct fire mode. In the latter a direct hit was obtained on a static target at a range of 750 m.

For these trials, the turret was fitted with elevation and traverse drives and a mock-up of a fire control system.

Royal Ordnance (Nottingham) responsible for turret and 120 mm ordnance, Delco Electronics (USA) responsible for electronics and systems integration and The Diesel Division, General Motors of Canada responsible for LAV (8×8) chassis, have formed a team to meet the potential requirements of the Saudi Arabian National Guard who have a requirement for an under armour mortar system as part of a complete family of 1117 Light Armored Vehicle's that it is to purchase under the US Foreign Military Sales (FMS) programme. Within this package is a total of 73 120 mm Armoured Mortar System's.

During 1992 Royal Ordnance undertook the design and construction of a complete turret system. This comprised a new all welded steel turret, 120 mm ordnance and a complete integrated fire control/sighting system integrated with a LAV (8 \times 8) chassis.

Live crew clearance was obtained late in 1992 and, following a demonstration in the UK late in 1992, it then went to the Middle East for further demonstrations and trials early in 1993.

The system has been designed with the capability to be fitted to a wide range of wheeled and tracked light armoured vehicle chassis, either new or as a retrofit.

Description

The 120 mm mortar has a semi-automatic conical screw, swinging breech mechanism with obturation being achieved with a Crossley pad. Firing is percussion mechanical activated by a solenoid. The recoil system consists of two hydropneumatic buffers and a pneumatic recuperator.

Sustained rate of fire of four rds/min, rapid rate of fire is eight rds/min (for three minutes maximum) and a burst rate of fire of three rounds in 15 seconds can be achieved.

Using standard ammunition a maximum range of 8000 m can be achieved and by using Royal Ordnance developed 120 mm mortar bombs a range of 8500 m can be achieved. With a rocket assisted projectile a range of 12 000 m can be achieved. In addition, the mortar can be used in the direct fire role to engage targets out to a range of 1500 m.

The weapon has been designed to fire all standard 120 mm smooth-bore ammunition together with Smart mortar bombs currently under development.

The new Royal Ordnance 120 mm mortar bomb has an obturator ring for improved sealing and a higher muzzle velocity. As the mortar can be fire in the indirect fire mode at much lower angles of elevation than a conventional mortar, it is much more difficult to detect with mortar locating radars.

The turret is fabricated from armour steel construction and provides stations for two crew, commander on the right and loader on the left. Each crewman is provided with a hatch for access and egress with an array of vision periscopes. Smoke dischargers are mounted either side of the turret front firing forwards and mounted on the turret roof is a 7.62 mm machine gun which is operated by the commander.

The full solution fire control system is a differential Global Positioning System (GPS) based system with automatic lay-on-command when target data is updated. The GPS system provides position, altitude direction and attitude (tilt and cant) data for the fire-control computer.

A number of targets can be entered into the system to allow rapid switching between them. For the direct fire role a thermal sight with integral laser rangefinder is provided.

The complete system is operational in all weathers with full reversionary modes available should power failure occur. Turret drives (traverse and elevation) are hydraulic.

The turret is designed to be modular to enable the internal fitments to be tailored to individual customer requirements.



Light Armored Vehicle (8×8) fitted with a Royal Ordnance 120 mm Armoured Mortar System during trials in the UK late in 1992 (Christopher F Foss)

CALIBRE 120 mm BARREL LENGTH **ELEVATING MASS** 866 kg TURRET MASS (typical) 3000 kg RECOIL LENGTH (max) 600 mm TRUNNION PULL (max) 130 kN **ELEVATING RANGE** -5° to +80° **OBTURATOR** Crossley pad **FUME EXTRACTOR** concentric, fitted to barrel BREECH MECHANISM FIRING semi-automatic, screw type electric with manual backup

Status: Prototype system successfully tested on an M113A2 and a full production standard demonstrator successfully tested on Light Armored Vehicle (8×8) chassis.

Manufacturer: Royal Ordnance, Kings Meadow Road, Nottingham NG2

1EQ, United Kingdom.

Telephone: (0602) 863341 Telex: 37531 Fax: (0602) 861436

Royal Ordnance 115 mm Tank Gun Barrel

Description

Royal Ordnance now offers a 115 mm smooth-bore tank gun barrel based upon the design of the former Soviet 115 mm U-5TS (2A20). This barrel is of a monobloc partial swage construction with a fume extractor secured by a screw fitting. The tank gun barrel can be produced for the replacement of existing worn gun barrels or may be fitted to new types of MBT designs. Ammunition that can be fired from this barrel includes APFSDS, HE-FRAG, HEAT-FS and Smoke.

SPECIFICATIONS

CALIBRE 115 mm
LENGTH
overall 5701 mm
bore 4961 mm
WEIGHT 1080 kg

Status: Production as required. In service with the Egyptian Army.

Manufacturer: Royal Ordnance, Kings Meadow Road, Nottingham NG2 1EQ. United Kingdom.

Telephone: (0602) 863341 Telex: 37531 Fax: (0602) 861436



Royal Ordnance manufactured 115 mm tank barrel for T-62 MBT from breech end but without breech mechanism installed

Royal Ordnance 105 mm L7 Tank Gun Series

Description

The Royal Ordnance 105 mm L7 tank gun was a direct development of the 20-pounder tank gun installed in the Centurion Mk 3 tank. The first service examples of the 105 mm L7A1 were introduced on the Centurion Mk 5 during 1959 and since then the 105 mm L7 series has become one of the most widely used tank guns in the western world. Royal Ordnance Nottingham has built some 20 000 L7 series guns and production continues for export. The only major change has been to the L7A3 standard which involves manufacturing expedients only. The gun is an orthodox design with a horizontal sliding breech-block. Breech obturation is obtained by using fixed ammunition with brass cases fired electrically. When fired, the gun recoils about 290 mm in most installations and a semi-automatic cam opens the breech to eject the spent case; the breech remains open for reloading. Recoil is controlled by two hydraulic buffer recuperators which dissipate the recoil energy and return the gun to the run-out position. The barrel is fitted with a bore evacuator and most installations involve the use of a thermal sleeve. Possible naval and coastal defence versions have been developed



The American version of the L7 is the M68 (qv) which has a different breech.

SPECIFICATIONS

CALIBRE 105 mm LENGTH 5588 mm ordnance recoil 290 mm WEIGHT 1282 kg RATE OF FIRE 10 rds/min max normal, manual 6 rds/min RANGE max effective, APDS 1800 m max effective, HESH 4000 m BARREL LIFE 200 EFC normal 800 EFC with additives

Status: In production. Installed on Centurion Mks 5/2, 6, 6/1, 6/2, 7/2, 8/2, 9, 9/1, 9/2, 10, 10/1, 10/2, 11, 12 and 13; Vickers MBT Mks 1 and 3; Leopard 1 MBT; Vijayanta MBT (gun produced in India); Upgraded Centurion (Israel and South Africa); Type 74 MBT (gun produced by Japan Steel Works); Strv 103B S tank (gun designated L74 and L/62 calibres long); Pz 61 and Pz 68 MBTs (gun produced in Switzerland); M48A2GA2 (Germany); T-55 (Egypt), M48A5, M60, M60A1, M60A3, M1, Merkava (Mks 1 and 2 only) and the South Korean Type 88 MBT. Also made in Israel, South Africa and USA (gv).

Manufacturer: Royal Ordnance, Kings Meadow Road, Nottingham NG2 1EQ, United Kingdom.

Telephone: (0602) 863341 Telex: 37531 Fax: (0602) 861436

Royal Ordnance 105 mm L7 tank gun

Royal Ordnance 105 mm Low Recoil Force Gun

Description

The Royal Ordnance Nottingham 105 mm Low Recoil Force (LRF) gun was developed from late 1982 as a private venture and late in 1983 it was announced that this would be the main armament of the American Cadillac Gage Textron 105 mm turret system, which is fully described in the *Turrets and Cupolas* section. By the end of 1985 four prototype guns had been completed. As of early 1993, the only application for this weapon was in the Stingray light tank of which 106 were ordered by Thailand in 1987. Royal

Ordnance Nottingham delivered production LRF guns to Cadillac Gage Textron between 1988 and 1990.

The ordnance is the basic 105 mm L7A3 complete with cradle and fitted with a specially designed recoil system to soften the force exerted at the trunnions. The ordnance is fitted with a new fume extractor that is concentric and a new multi-baffle muzzle brake. For compactness and ease of training a collapsible recoil guard is now installed.

The turret can be fitted to light vehicles such as the Cadillac Gage V-600 Commando vehicle, the M41 light tank and the Stingray as well as heavier vehicles such as the T-54/T-55 and M47 tanks.

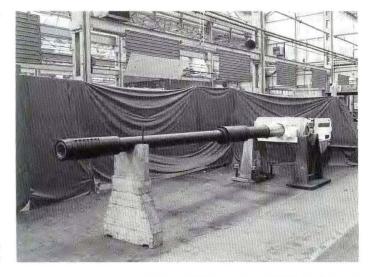
34 WEAPONS OF 20 mm AND UPWARD / UK

SPECIFICATIONS CALIBRE LENGTH	105 mm	HEIGHT overall excluding spent case bag	554 mm	WIDTH over trunnions over side plates	966.5 mm 838 mm
from trunnions to end of muzzle brake	4562 mm	below trunnion centreline including spent bag	660 mm	WEIGHT (overall including recoil guard)	1932 ka
from trunnions to end of	f	below trunnion centreline		SERVICE RECOIL LENGTH	762 mm
recoil guard	2203 mm	including SA bracket	380 mm	SERVICE TRUNNION PULL	11 600 kg
overall	6753 mm	above trunnion centreline	240 mm		

Status: Production as required. In service with Royal Thai Army on Cadillac Gage Textron Stingray light tanks.

Manufacturer: Royal Ordnance, Kings Meadow Road, Nottingham NG2 1EQ, United Kingdom.

Telephone: (0602) 863341 Telex: 37531 Fax: (0602) 861436



Royal Ordnance 105 mm Low Recoil Force Gun showing muzzle brake and elevating mass

Royal Ordnance 105 mm T-54, T-55 and Type 59 Gun Conversions

Development/Description

Royal Ordnance Nottingham has successfully completed design work to enable the 105 mm L7A3 gun to be installed in the former Soviet-built T-54/T-55 MBT. This conversion significantly improves first round hit probability and enables the latest high performance kinetic ammunition to be fired. The original 100 mm D-10TS gun (in the T-55) is loaded from the right but in Western tanks it is loaded from the left. The L7 has, therefore, been turned through 180°. A revised recoil system has been designed which includes new buffer components and modified recuperator, so maintaining trunnion pulls consistent with the original system and a rebalanced elevating mass. Other work has included the design and manufacture of two fuel tanks

positioned in the hull with new ammunition racks with the fuel tanks, modified main and emergency firing circuits and a new telescopic graticule to suit the new range of ammunition and the coaxial 7.62 mm machine gun. An additional advantage of this conversion, which has been carried out at the original request of Egypt, is that the gun barrel can now be withdrawn through the cradle; in the past the complete turret had to be removed.

A similar conversion but involving the fitting of an improved elevating mass, comprising a new cradle and recoil system, has also been carried out on a Chinese-built Type 59 MBT.

SPECIFICATIONS

CALIBRE	105 mm
LENGTH OF ORDNANCE	5588 mm
WEIGHT OF ORDNANCE	1287 kg
RATE OF FIRE	6 rds/min

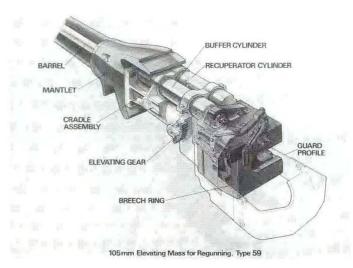
Status: Development complete. Production as required. Ordered by Egypt for its T-54/T-55 MBTs in June 1985. The Type 59 conversion has been evaluated in Pakistan but has yet to enter series production.

Manufacturer: Royal Ordnance, Kings Meadow Road, Nottingham NG2 1EQ, United Kingdom.

Telephone: (0602) 863341 Telex: 37531 Fax: (0602) 861436



Chinese Type 59 MBT with 105 mm L7A3 tank gun



105 mm elevating mass for regunning Chinese Type 59 MBT with 105 mm L7 series tank gun

Royal Ordnance 105 mm Improved Weapon System

Description

The 105 mm Improved Weapon System (IWS) was announced late in 1989 and has been developed as a private venture by Royal Ordnance, with the Ammunition Division being the overall systems authority and having responsibility for the new 105 mm APFSDS round, and the Guns & Vehicles Division being responsible for the complete ordnance and breech.

The high pressure IWS has a rifled barrel of Electro Slag Refined (ESR) steel fitted with a fume extractor, thermal sleeve, horizontal sliding breech mechanism and pepperpot muzzle brake that reduces recoil forces by 25 per cent. The interior of the IWS ordnance is chrome lined to give increased barrel life.

Royal Ordnance is considering offering a muzzle reference system for the IWS but the flat trajectory of the APFSDS rounds makes this of marginal use in a NATO operational environment.

Firing a new APFSDS round, Royal Ordnance claims a performance penetration equivalent to a 120 mm smooth-bore gun, superior to all current 105 mm APFSDS rounds. No actual details of penetration have been released but, based on available information, penetration of 540 mm of rolled homogenous armour at a range of 2000 m is probable.

The new IWS is almost a direct replacement for the current 105 mm L7 and uses the existing recoil system and cradle. The existing sights would have to be modified as well as the ready racks to accommodate the new APFSDS rounds. The IWS was demonstrated late in 1989 fitted in a Leopard 1 MBT. Conversion work can be carried out at base workshop level with no special equipment being required.

A new high performance APFSDS round with conventional material penetrator of tungsten nickel iron, rather than depleted uranium and a semi-combustible cartridge case, has been developed by Royal Ordnance.

The new APFSDS round weighs a total of 19 kg and is 1.03 m long with a muzzle velocity of 1420 m/s. The Tungsten-Nickel-Iron (W-Ni-Fe) long rod penetrator, manufactured by Royal Ordnance Speciality Metals, is located in a three segment sabot which has been designed to reduce parasitic weight to a minimum.

The length-to-diameter ratio is 23/1, the new round does not have a tracer element and the fins of the projectile are of steel.

According to Royal Ordnance, the penetrator has a mass approximately 40 per cent greater than that of current 105 mm APFSDS rounds.

The propelling charge comprises a stub brass cartridge case and a combustible sleeve which together house the multi-base granular propellant and primer.

The IWS can fire all existing 105 mm NATO rounds including APFSDS and training types. Built-in safety features ensure that the new high pressure round cannot be loaded into standard 105 mm L7 guns or into an IWS incorporating L7 components.

So far, the IWS has been installed in an early Leopard 1 MBT (form and fit trials), a C1 Leopard 1 MBT of the Canadian Armed Forces (firing trials in the UK) and, late in 1991, in a German Army Leopard 1A5 (firing trials).

By late 1991 development of the 105 mm Improved Weapon System had been completed and production equipments could be available in late 1993/early 1994, depending on early receipt of orders. The design of the new APFSDS-T round for the IWS is being optimised.

SPECIFICATIONS

105 mm CALIBRE TOTAL LENGTH OF WEAPON 6810 mm TOTAL LENGTH OF BARREL 6658 mm RECOIL LENGTH 279 mm WEIGHT OF BARREL 1334 kg 450 EFC (min) BARREL LIFE

Status: Development complete. Ready for production on receipt of orders.

Manufacturer: Royal Ordnance, Kings Meadow Road, Nottingham NG2 1EQ. United Kingdom.

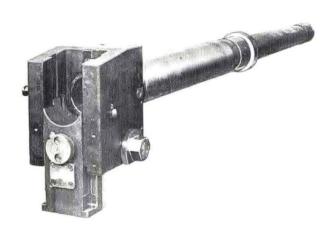
Telephone: (0602) 863341 Telex: 37531 Fax: (0602) 861436



Leopard 1 MBT of the Canadian Armed Forces fitted with Royal Ordnance 105 mm Improved Weapon System

Royal Ordnance 76 mm L23A1 Gun

The L23A1 was developed from the essentially similar but heavier 76 mm L5A1 which is no longer in production. The L5A1 76 mm gun was installed in the Alvis Saladin 6 × 6 armoured car that is still used by many countries. The L23A1 is an orthodox steel rifled gun with a semi-automatic vertical sliding breech-block. No muzzle brake or bore evacuators are fitted. Fixed



ammunition is fired. Firing can be electromechanical using a solenoid or purely mechanical using a foot-firing pedal. The recoil system is hydropneumatic. During run-out the breech is opened by a semi-automatic cam and the empty case ejected; the breech remains open ready for reloading.

SPECIFICATIONS

CALIBRE 76.2 mm LENGTH 2062 mm ordnance recoil 280 mm WEIGHT (complete) 150.59 kg RATE OF FIRE 6 rds/min RANGE max, direct max, indirect 5000 m BARREL LIFE 4750 EFC RECOIL LENGTH

Status: In production. Installed in FV101 Scorpion; M113A1 fire support vehicle (in service with Australia); Cougar (6 x 6) wheeled fire support vehicle (in service with Canada); Cadillac Gage V-150 Commando (4 × 4) (proposal); Cadillac Gage V-300 Commando (6 × 6) (proposal).

Manufacturer: Royal Ordnance, Kings Meadow Road, Nottingham NG2 1EQ, United Kingdom.

Telephone: (0602) 863341 Telex: 37531 Fax: (0602) 861436

76 mm L23A1 tank gun

Royal Ordnance 30 mm RARDEN L21 Gun

Description

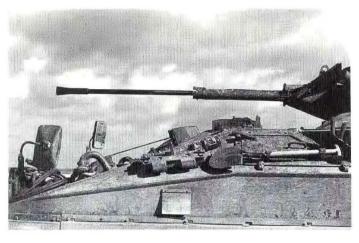
The 30 mm RARDEN Gun was developed by the Royal Small Arms Factory at Enfield Lock (which closed in 1988) and the Royal Armament Research and Development Establishment at Fort Halstead during the mid-1960s, and the first prototype was produced in 1966. The first pre-production version was produced in 1968 and the first service versions appeared during the early 1970s. The design philosophy of the gun was that it should have a restricted rate of fire so that it could be installed in relatively light armoured vehicle turrets but still fire accurately enough to deliver a sufficiently lethal projectile to destroy APCs and similar vehicles at ranges of over 1000 m. The RARDEN Gun fires 30 mm Hispano-Suiza 831 L rounds and RARDEdeveloped ammunition, and it operates on the 'long-recoil' system in which the barrel and breech initially recoil together. At one point the barrel recoil ceases while the breech recoil continues to extract the spent case. The barrel then moves forward again, followed after an interval by the breech which loads another round. The system on the RARDEN is fully enclosed, and the internal section of the gun protrudes only 430 mm into the turret space. The gun can hold six rounds which are fed in three-round clips. The gun is charged by a small cocking/loading handle and spent cases are ejected forward from the gun. No firing fumes or cases can penetrate into the turret area. Normally, the gun fires single shots only but six-round bursts are possible. Accuracy is such that 1 m groups at 1000 m have been fired.

The current contract, which involves deliveries to GKN Defence for installation in the Warrior mechanised combat vehicle, is continuing at Royal Ordnance Nottingham after production had been transferred from BMARC in early 1993 (Royal Ordnance purchased BMARC in April 1992).

In the future, some British Army Scorpion vehicles will have their 76 mm turrets removed and replaced by turrets removed from the Fox armoured car armed with the 30 mm RARDEN cannon. The Fox is being phased out of British Army service.

SPECIFICATIONS

CALIBRE 30 mm LENGTH 3150 mm overall barrel 2438 mm inboard length 430 mm WEIGHT 110 kg complete barrel 24.5 kg RATE OF FIRE (cyclic) 80-90 rds/min RANGE max 4000 m effective 1000 m TRUNNION LOAD 13.34 kN



30 mm RARDEN Gun installed on GKN Defence Warrior mechanised combat vehicle (Henry Dodds)

Status: In production. Installed in FV107 Scimitar; FV721 Fox; Warrior; FV432 (small batch only); Steyr 4K 7FA-SP2/300 MICV (prototype).

Manufacturer: Royal Ordnance, Kings Meadow Road, Nottingham NG2 1EQ, United Kingdom.

Telephone: (0602) 863341 Telex: 37531 Fax: (0602) 861436

UNITED STATES OF AMERICA

General Electric Liquid Propellant Guns

Development/Description

Liquid propellants offer many advantages over conventional solid propellants. Using liquid propellants the need for the handling (automatic or manual) of bulky cartridge cases or charge bags becomes unnecessary, leading to a saving of weight, complexity and space around a gun; any associated autoloading system needs to be concerned only with projectiles and there is no need to dispose of non-combustible cases or stubs. There is also the possibility of a significant saving in propellant stowage requirements. Liquid propellants also offer a saving in overall firing costs, an improved degree of safety due to the low vulnerability of most of the liquid propellant substances involved to battle damage and the possibility of reduced firing flash and blast. There is also the possibility that muzzle velocities could be made more uniform over a series of firings, thereby increasing accuracy by reducing dispersion, and that increased rates of fire could be made possible.

Liquid propellant guns fall into two main categories, bulk-loaded liquid propellant guns and regenerative liquid propellant guns. In the former the liquid propellant is injected into the gun chamber and ignited to produce a single propulsive action. In contrast, with the regenerative system, liquid propellant is injected into the chamber in a stream or aerosol spray that is ignited as it enters. To date much of the research work carried out in the USA has involved regenerative liquid propellant guns.

Liquid propellants currently under investigation fall into two main categories

General Electric Liquid Propellant Gun No 2 on the firing range

with numerous variations within each, according to the materials involved. Mono-propellants contain combined fuel and oxidiser. Bi-propellants have their fuel and oxidiser held separately. A third group of possible liquid propellants are known as hypergolic, ie they react spontaneously when combined. Hypergolic propellants have to date received little consideration for military purposes due to the difficulties in handling them safely under artillery and AFV armament conditions.

By the 1970s liquid propellant research in the USA involved regenerative liquid propellant guns and various forms of mono-propellants. Several programmes have been initiated by the US Navy, the Defense Advanced Research Projects Agency (DARPA) and the Armament Research, Development and Engineering Center (ARDEC).

General Electric was carrying out research into regenerative liquid propellant weapons using test rigs with calibres of 8, 25 and 30 mm during the mid-1970s and by 1983 had accumulated a data base founded on more than 2000 firings conducted from a variety of test rigs incorporating barrels of .35 in, 25 mm and 105 mm.

In 1984, the Ballistic Research Laboratory awarded General Electric's Tactical Systems Department a contract to deliver a fixed 155 mm Regenerative Liquid Propellant Gun for demonstration in 1989.

Late in 1990, General Electric allocated the name Defender to their 155 mm liquid propellent gun system. At this time General Electric stated that the first LP gun commenced firing in July 1988 and had demonstrated range capability from Zone 1 to Zone 8, velocity repeatability of 0.25 per cent and propellant fill accuracy of 0.032 per cent.

Gun No 1 was essentially a modified 155 mm XM283 tube with a specially designed swing breech mechanism mounted on a modified 203 mm (8 in) towed howitzer carriage.

It was an experimental test fixture with a single shot capability and was capable of firing the existing family of 155 mm projectiles at muzzle velocities from 240 to 725 m/s but required a hardware change to change zone of ballistic cycle.

Gun No 2 is more compact than No 1 and has a different breech mechanism. It has a three round burst fire capability at a rate of up to 7 rds/min.

It is also capable of multiple zoning and ballistic cycle without hardware changes and is capable of firing the existing family of 155 mm projectiles with muzzle velocities from 300 to 1005 m/s out to a maximum range of more than 44 km.

Other features of Gun No 2 include:

Electronic Gun Control

Automated firing control Step-by-step firing control Built-in gun malfunction detection Controls download

Fill System

Brassboard fill system complete and operating Fill accuracy demonstrated at 0.03 per cent full scale Pressure pulse transients controlled

Automatic Loader

Installed on weapon Achieving seating velocity of 11 ft/s Multi-round clip ready Computer control integrated Automatic operation working

Gun No 3 is now designated the XM300 by the US Army and will be fully functional with weight and size characteristics of a fieldable weapon. It will have a rate of fire of up to 12 rds/min and be capable of firing the existing family of 155 mm projectiles.

Cost

80 per cent reduction in propellant costs Flexibility in vehicle design

Operational

Minimum range less than 6 km Maximum range more than 40 km 0.26 per cent velocity repeatability Up to 48 per cent greater range for all projectiles At least four rounds single gun time on target from 8 to 37 km Simplified automatic loader as it handles only projectiles 12 rds/min firing rate 100 per cent increase in onboard ammunition storage Improved force efficiency

Survivability

An insensitive munition Reduced muzzle flash Reduced muzzle blast Low trajectory options Greater mission flexibility

Logistics

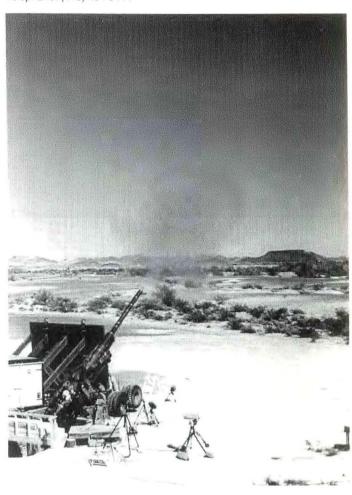
Simplified logistics systems Propellant packaging flexibility from bulk to small increments 22 per cent more rounds of PLS flat rack 48 per cent load increased in Future Armored Resupply Vehicle

Further investigations are being carried out to produce a concept for a liquid propellant gun suitable for installation as the main armament for AFVs involving a principle known as the liquid propellant travelling charge. With this system the travelling charge acts as a high pressure in-bore rocket to produce high kinetic energy with relatively little increase in gun weight. An investigation carried out by General Electric for the US Army Ballistics Research Laboratory during 1985 indicated that it would be possible to produce a liquid propellant travelling charge gun capable of firing 120 mm projectiles with a muzzle velocity of between 2000 and 3000 m/s. A similar gun and liquid propellant system installed in an M1A1 Abrams-type MBT could produce a rate of fire of up to 20 rds/min (firing armour-piercing projectiles) and would permit the stowage of up to 48 ready-to-fire projectiles. Alternatively, a smaller oun turret and installation for the weapon could produce a lower or better protected vehicle overall.

Status: Advanced development.

Prime contractor: General Electric Defense Systems Department, Liquid Propellant Programmes, 100 Plastics Avenue, Pittsfield, Massachusetts 01201, USA.

Telephone: (413) 494 3414



General Electric Gun No 2 during firing programme at Yuma Proving Ground early in 1992. Note the projectile upper right and lack of any muzzle flash

FMC Electrothermal-Chemical (ETC) Gun **Propulsion System**

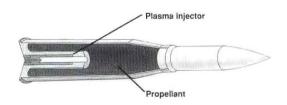
Development/Description

Developed and patented by FMC, Combustion Augmented Plasma (CAP™) is a controllable, and highly repeatable Electrothermal-Chemical (ETC) gun

Developed to use current gun components and fit within the ballistics parameters of gun barrel designs, the ETC/CAP™ process can be utilised for gun retrofit as well as new start applications. The hybrid process uses a powerful electric pulse to generate plasma which reacts with propellants configured in a conventional cartridge. The reacting mixture launches the projectile at high velocity while it cools and lubricates the gun tube.

Tests have shown that ETC/CAP™ propulsion offers a significant improvement in muzzle velocity over conventional guns. Tests indicate that ETC/CAP™ reduces the time of projectile flight and can provide a considerable enhancement in stand-off range and armour penetration for future gun weapon systems.

ETC/CAP™ also provides a greater degree of propulsion control than



The CAP™ propulsion approach utilises an electrical discharge fed into a gun to create plasma which is mixed with the fuel and oxidiser in the chamber

conventional, or Liquid Propellant (LP) guns. This is achieved through the use of a Pulse Forming Network, or 'PFN' which precisely regulates the electric pulse used for ignition.

Both conventional and LP propulsion create an intense energy 'SPIKE' at ignition. With ETC/CAP™, the PFN controls the intensity and duration of the electrical pulse and, working in combination with propellants, provides for a more controlled acceleration. Peak pressure behind the projectile can be controlled and tailored to match pressure-time curves of gun chamber, barrel, and projectile designs.

The process can meet critical acceleration profiles for smart munitions containing embedded electronics, and allow projectiles to achieve greater velocity without exceeding acceleration force limits.

The ETC/CAP™ approach uses an efficient, energetic propellant which minimises electrical energy and power supply requirements. This provides for a considerable reduction in total system weight when compared with advanced gun designs using pure electromagnetic (EM) or ET processes. The volume of the CAP™ power generating and power supply system is approximately one-fifth that of similar components for a gun.

ETC/CAP™ employment concepts include applications for land fire support and naval gunfire support, with a range potential of 50 km. Close combat concepts include both main battle tank and light armoured vehicle applications. In addition, there are small calibre applications for naval ship self-defence, terminal ballistic missile defence, and unique army all-electric gun approaches

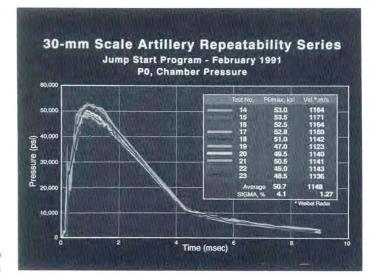
CAP™ technology is also readily adaptable to conventional gun weapons, providing strong potential for retrofit applications in a number of existing gun and cannon systems. Such a conversion can significantly improve existing gun performance at a lower cost than 'upgunning' conventional designs to a larger calibre.

FMC's CAP™ gun technology has been successfully test fired in 10 mm, 30 mm, 90 mm, 105 mm and 120 mm gun configurations. Development milestones are being met to enable 155 mm tests in 1993

Details of specific applications of this technology are given in the following

Research/Developer: FMC Corporation, Naval Systems Division, 4800 East River Road, Minneapolis, Minnesota 55421-1498, USA.

Telephone: (612) 571 9201



The CAP™ combustion process has demonstrated a high degree of ballistic repeatability in live firing tests

FMC/US Army Laboratory Electrothermal-Chemical Gun Development

Development/Description

In 1988 the United States Army awarded FMC a contract to design and build an indoor test range and laboratory ETC gun.

The ETC Laboratory gun contract includes adaptive development of:

- (a) 120 mm breech mechanism using the currently fielded M1A1 breech designed by Watervliet Arsenal
- (b) M174 120 mm gun mount equipped with M110 (203 mm) Self-Propelled Howitzer recoil mechanism to ensure labgun stability
- (c) Gun support structure (BRL design)
- (d) High power electrical connections (FMC design)
- (e) Gun sleigh (BRL design).

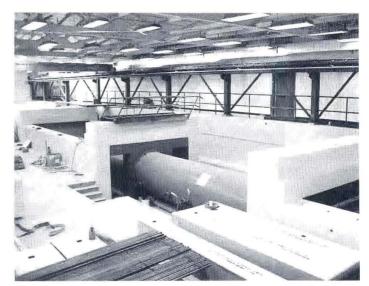
The Laboratory ETC gun is designed to launch 2.94 kg projectiles at more than 8200 ft/s. The complete ETC gun system delivered by FMC to the US Army Armament Research, Development, and Engineering Center (ARDEC) will be used to support continued development in Electrothermal-Chemical designs for future close combat and fire support applications, as well as EM gun tests.

This facility was completed and the ETC gun delivered to the US Government for testing in March 1992 after successfully completing verification testing.

SPECIFICATIONS (Laboratory ETC Gun)

MUZZLE ENERGY 9 MJ LAUNCH VELOCITY 1.9 km/s LAUNCH PACKAGE 5.0 kg

Indoor range/diagnostics Building 717 Picatinny Arsenal Used for ET and EM shots 120 mm CAP™ gun



Continued ETC development will be enhanced by the US Army's indoor test range and laboratory facility, part of which was designed and constructed by FMC

Status: Developmental testing for US Army.

Research/Developer: FMC Corporation, Naval Systems Division, 4800 East River Road, Minneapolis, Minnesota 55421-1498, USA.

Telephone: (612) 571 9201

FMC/US Army 9-MJ Electrothermal Skid Gun Module

Development/Description

FMC is under contract with the US Army and the Balanced Technology Initiative (BTI) to develop the prototype of a 9-MJ electrothermal skid gun and its associated Pulse Power Module (PPM).

The pulse power module has been fabricated and was extensively tested in FY1992.

The 9-MJ electrothermal skid gun will operate with an 8.5 MJ Pulse Power Module (PPM) which is self-contained and transportable. The PPM is of a modular design to allow adaptation to future technology. The PPM has been designed to provide output pulse shape flexibility to operate a variety of electrothermal guns.

Primary components of the PPM include:

- (a) System controller and operators console to: monitor/control all pulse power and gun system functions
- (b) Auxiliary power system for: environmental control, battery charging, housekeeping power
- (c) Lead acid battery system: prime power (100 MJ delivered at 400 V DC)
- (d) DC/DC converter (600 kW average, 1200 kW peak power constant 75 A output)
- (e) Pulse forming network (four 2.125 MJ banks)
- (f) High energy density capacitors (85 kJ at 16 kV).



The modular PPM is a transportable pulse power source for use in various ETC gun projects

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The 8.5 MJ PPM represents a significant step towards power supply downsizing, a critical aspect of ETC/CAPTM weaponisation and vehicle integration. This latest capacitor-based 8.5 MJ pulse power unit has a capacitor energy storage density of 1.5 kJ/kg, a five-fold improvement in energy storage volume from the state-of-the-art systems of just two years ago.

FMC is targeting a storage energy density goal of 10 kJ/kg to permit ETC/CAP™ integration to current naval and land fire support platforms, and other future weapon systems. Continued progress in battery and capacitor technologies indicate that these sufficiently compact systems can be built by the year 2000.

SPECIFICATIONS (9-MJ ET Skid Gun Module)

 Required
 Delivered

 MUZZLE ENERGY
 9 MJ
 17 MJ

 LAUNCH VELOCITY
 2.2 km/s
 1.7 km/s

 LAUNCH PACKAGE
 3.7 kg
 11.8 kg

 REPETITIVE LAUNCH RATE
 9 rds in 3 mins

Status: Under development for US Army.

Research/Developer: FMC Corporation, Naval Systems Division, 4800 East River Road, Minneapolis, Minnesota 55421-1498, USA.

Telephone: (612) 571 9201

US Army ETC and Gun Propulsion Process Development

Development/Description

FMC is under contract with the US Army for continued research in Electrothermal-Chemical (ETC) gun propulsion process development. The Army's Electrical Enhancement Factor (EEF) Follow-on Program will evaluate ETC potential by seeking to understand and control the ballistic process.

This follows FMC work performed in 1989, when a US Army 120 mm M1A1 tank cannon was adapted to ETC propulsion. The test produced muzzle velocities over 5600 ft/s with an 11.34 kg projectile mass.

The EEF Follow-on Program tested the ETC approach in small calibre gun fixtures during the first year, and moved to large calibre tests when specific performance objectives were met. A 1993 decision point on programme extension will include the following criteria:

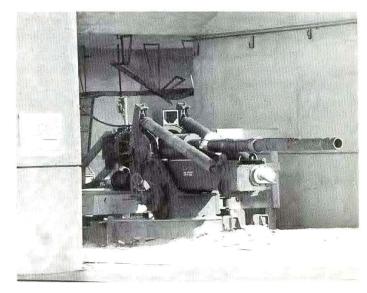
(a) 15 per cent performance improvement over existing propellants

- (b) Repeatable at <0.5 per cent deviation
- (c) Predictable performance

(d) Research resulting in a militarily-practical propellant.

The EEF Follow-on Program builds on FMC's prior research in ETC guns, and is a continuation of work performed for the US Army Armament Research Development and Engineering Center and Ballistic Research Laboratory over the past two years. FMC has demonstrated muzzle velocity improvements of 16 per cent to 30 per cent with less than a 1.0 per cent deviation in scaled fixtures. Ongoing tests use US Army approved propellants.

Status: Under development for the US Army.



120 mm ETC gun during testing at Aberdeen Proving Grounds, Maryland

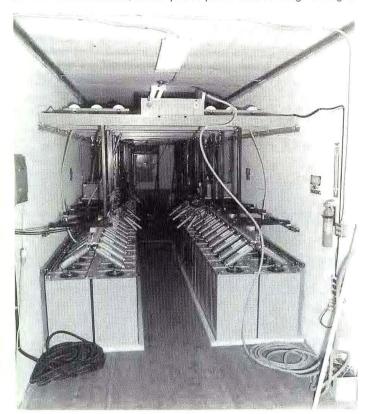
Research/Developer: FMC Corporation, Naval Systems Division, 4800 East River Road, Minneapolis, Minnesota 55421-1498, USA.

Telephone: (612) 571 9201

FMC Pulsed Power Development

Development/Description

A key enabling technology for ETC weapons is pulsed power. FMC pioneered the use of self-contained, mobile pulsed power units for range testing at



multiple test sites, and as a means of demonstrating component miniaturisation and durability, as well as technical maturity.

FMC is under contract with the US Army to develop the prototype of a 9-MJ electrothermal skid gun and its associated Pulse Power Module (PPM). (See previous section on the ARDEC/FMC 9 MJ Pulsed Power Gun.)

The 9-MJ electrothermal skid gun will operate with an 8.5 MJ Pulse Power Module (PPM) which is self-contained and transportable. The PPM is of a modular design to allow adaptation to future technology. The PPM has been designed with pulse shape output flexibility which will allow it to operate a variety of electrothermal guns.

FMC-funded pulsed power developments include a stationary 5-MJ Pulse Forming Network (PFN) for laboratory testing, and mobile 5-MJ and 11-MJ PFNs for future ETC range testing. FMC has demonstrated very efficient packaging of pulsed power components and has used a system architecture that maximises flexibility while minimising fault loads. For high energy



FMC Pulsed Power Modules utilised for ETC/CAP™ gun laboratory and range testing include mobile 5 MJ (upper), and 11 MJ (lower) units

storage systems, the resulting density of 0.8 MJ/m $^{\rm 3}$ for a fully integrated PFN is the highest to date, and is only a factor of two to five less than that required for integration into most weapons system platforms.

CAPTM technology offers considerable reduction in total weapon system weight when compared with advanced gun designs using Electromagnetic (EM) and advanced conventional technologies. The volume of the CAPTM power generating and pulsed power system is approximately one-third to one-fifth that of similar components for an EM gun.

Continued pulsed power development, including improved integration

efficiency and component miniaturisation, could reduce the power supply volume significantly by the late 1990s to support the next generation of gun weapon systems.

Status: Development.

Research/Developer: FMC Corporation, Naval Systems Division, 4800 East River Road, Minneapolis, Minnesota 55421-1498, USA.

Telephone: (612) 571 9201

FMC Electromagnetic Focused Technology Demonstrator (EMFTD)

Development/Description

FMC is under contract for work leading to the development of an Electromagnetic Focused Technology Demonstrator (EMFTD). The EMFTD contract is a key part of the US Army's programme for the development of technology, components and sub-systems required for electric guns and launchers.

The mission focus of EMFTD is anti-armour with potential applications to air defence, fire support, theatre missile defence and infantry fighting roles.

FMC was awarded Phase One of a five phase contract by the US Army's Armament Research, Development and Engineering Center (ARDEC).

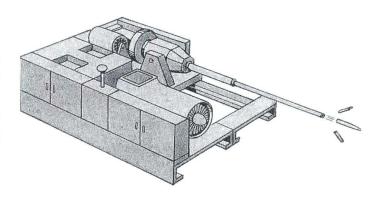
The five phases of this contract are:

- (1) Concept development
- (2) Technology enhancement
- (3) Critical component development
- (4) Component test and integration

(5) Sub-system engineering, integration and testing.

According to FMC, the EMFTD effort is expected to yield significant advancements in state-of-the art electromagnetic launchers, pulsed power, power and energy storage, projectile interface and key systems integration aspects.

As the EMFTD team leader, FMC's responsibilities include system concept development, sub-system interface and test system control, system integration and prime contract management. The FMC led team comprises the following companies: Sparta, Physics International, General Atomics, Westinghouse Science and Technology, W.J. Schafer Associates, Aerovox, General Electric Re-Entry Systems, Hughes Research Laboratories, Westinghouse Naval Systems, Pinnacle Research and Magnatek.



FMC EMFTD concept drawing of power module and gun system on mated skids

Status: Under development for US Army ARDEC.

Research/Development: FMC Corporation, Naval Systems Division, 4800 East River Road, Minneapolis, Minnesota 55421-1498, USA. Telephone: (612) 571 9201

General Dynamics ETC

Development/Description

For some years, General Dynamics, Land Systems Division, has been working on ETC (Electrothermal/Chemical) gun technology. Originally this was as a private venture but more recently funding has been provided by the US Army (120 mm) and US Navy (60 mm) weapons.

In 1991, the company opened the new 326 acre Mason Technology Center at Ashton, West Virginia, where all ETC development and testing work is now being concentrated.

This facility is provided with test chambers for the General Dynamics, Land Systems Division, 120 mm tank gun cannon, 155 mm cannon and a 60 mm air defence cannon (FMC being the other competitor in this programme).

It also has a control centre with full instrumentation and on site data collection, and 4.5 MJ range target pad that can be increased to 1000 m.

According to General Dynamics, Land Systems Division, this new purpose built test facility enables the company to build on its past successes in Electrothermal/Chemical Gun Technology including:

(1) Demonstrated increased energy levels

(2) Demonstrated decreased power supply requirements

(3) Demonstrated enhanced safety and survivability in propellant chemistry.

Status: Development, including US Army/Navy contracts.

Manufacturer: General Dynamics, Land Systems Division, PO Box 2074, Warren, Michigan 48090, USA.

Telephone: (313) 825 4000

Laser Weapon Programmes

Development/Description

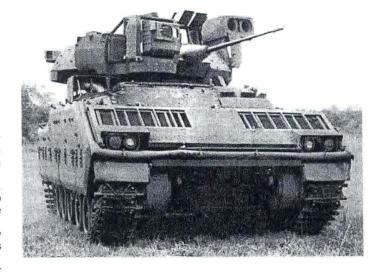
The United States Armed Forces have been engaged in a variety of laser weapon projects for many years. Some of these have had an air defence application, such as the now defunct High Energy Laser Tactical Air Defence System (HELTADS) developed in the 1970s, while others have been designed to destroy sensors and optics, an example of the latter being the US Army Stingray project.

Stingray is an outgrowth of the C-CLAW (Close Combat Laser Weapon) project which was designed to blind enemy sensors. The prototype system, often called the Roadrunner, was a 1 kW weapon using a pulsed CO₂ laser with an Nd-YAG laser operating at 0.53 or 1.6 μ m as a supplement. The C-CLAW project was cancelled in 1983 for a variety of reasons including failure to meet cost and weight goals.

Field trials of the Stingray laser weapon system commenced late in 1989. The system is based on an FMC Bradley chassis and has been designed to blind enemy periscopes, night vision equipment and gun sights on a wide range of battlefield weapon systems, so rendering them ineffective.

The laser in Stingray has been developed by the US Army Communications and Electronics Command and Martin Marietta Electronics Systems.

Early in 1991, the US Army stated that "Stingray is a low energy laser system used to detect and counter threat optical and electro-optical fire



Stingray advanced development system with optics on right side of turret

control systems. By using the Stingray as a force multiplier, the battlefield commander can cover large frontages with fewer sources, establish a more effective reserve force, and reduce friendly combat casualties

Stingray is intended as an adjunct to the M2/M3 Bradley Fighting Vehicle System (BFVS), can be mounted on the HMMWV, and is a candidate for integration into the Armored Systems Modernization. The BFVS adjunct Stingray consists of an armoured add-on External Stabilisation Unit (ESU) with gimballed platform and equipment enclosures, and an internal configuration of supporting electronics and an operation control panel. Two developmental prototypes exist with full scale development scheduled to commence in FY92. Initial production of the 48 Block I Systems to be built is scheduled to begin in FY95 with system fielding occurring in FY96 through to FY98

Unconfirmed reports have indicated that the two prototype systems were deployed to the Middle East during Operation Desert Shield/Desert Storm.

In late 1991, Martin Marietta submitted a Stingray proposal in response to a solicitation from the US Army's Communications and Electronics Command. The projected programme will provide six additional Stingray units under an Engineering and Manufacturing Development (EMD) programme followed by 158 additional vehicles in low rate production.

Status: Field trials.

140 mm Advanced Tank Cannon (ATAC) System

Development/Description

The 140 mm smooth-bore Advanced Tank Cannon (ATAC) System consists of the XM291 gun, the XM91 autoloading system and a family of 140 mm

The ATAC System was expected to be the main armament of the US Army's future Block III MBT, a key part of the projected Armored Systems

The ATACS is being installed in the Component Advanced Technology Test Bed (CATT-B). This is based on a M1A1 Abrams chassis and, in addition to the ATAC System, is expected to have the Cummins Advanced Integrated Propulsion System (AIPS), hydropneumatic suspension, Standard Army Vetronics Architecture, Rockwell Multi-sensor Target Acquisition Sensor, CDC ADA based fire control system, light weight track, modular armour, advanced chemical agent alarm, NBC collective protection system and a Vehicle Integrated Defense System with countermeasures, threat sensors and smoke.

Prior to being installed in the CATT-B, the ATAC System has been installed in a modified M1 turret on a standard M1 chassis. This also features the Benet Laboratory designed automatic loader, modified M1A1 fire control electronics, Rockwell Multi-sensor Target Acquisition Sensor (qv), standard M1 gunner's primary sight and a new fire control computer. In this vehicle the gunner is on the right, as in the M1, while the tank commander is on the left in the space normally occupied by the loader.

The XM291 gun is a solid propellant tank gun with an integral mount and recoil mechanism that fires two piece (eg projectile and charge) ammunition with twice the muzzle energy of the standard 120 mm M256 gun installed in the current M1A1 and M1A2 Abrams MBTs. The ordnance is fitted with a thermal sleeve, fume extractor and is 91 kg lighter than the standard 120 mm M256 ordnance.

By means of a simple tube change, which takes one hour to accomplish, the system can also fire 120 mm one piece conventional and advanced ammunition.

During operation of the XM91 autoloading system, developed by the US Army's Benet Laboratory, the selected ammunition type is identified, the telescoped cell containing that cartridge is moved to the loading port and the loading door is opened. The rammer mechanism then moves forward and grasps the rim of the stub base, the round gripper mechanism which holds the cartridge in place is released and the inner cell moves forward.

Docking of the inner cell with the breech occurs on full extension and the round is seated in the gun. The ram head and the inner cell then retract to their original position and the loading door is closed. The down loading sequence is similar and an ammunition rearm port is provided at the rear of the autoloader for that procedure.

The ammunition transfer mechanism has been developed by General Electric with the ready use bustle-mounted magazine holding 17 120 mm or 140 mm rounds, with the hull magazine holding 22 140 mm two piece rounds as components or 33 single-piece 120 mm rounds.

Automatic loading takes place at the rate of 8 to 12 rds/min, with the rammer being provided by Brunswick Defense (qv).

The ATAC System family of ammunition consists of three cartridges: the XM964 kinetic energy (KE) cartridge; the XM965 chemical energy (CE) cartridge; and the XM966 training cartridge for both rounds.

Each cartridge consists of a forward and rear component. The rear component, which is identical to all three cartridges, consists of a stub base and primer assembly (similar to that of a standard 120 mm cartridge), a combustible side wall, an ignition system and propellant.

The forward component houses the appropriate projectile, partially telescoped within the primary propelling charge, and propellant in a combustible cartridge case which also contains a relay charge at its base for the transfer of ignition from the rear component. A snap joint joins the two components allowing cartridge removal from the breech. The cartridges offer a muzzle energy that is double that of the standard 120 mm system.

The 140 mm ATACS was preceeded by a 'Lightweight 120 mm Tank Main Armament System' and details of this were given in Jane's Armoured Fighting Vehicle Retrofit Systems 1990-91 page 35.

Status: Prototypes undergoing US Army trials.

Development Agency: US Army Armament, Research, Development and Engineering Center (ARDEC), Picatinny Arsenal, New Jersey 07806-5000,



The 140 mm XM291 gun which forms part of the US Army's Advanced Tank Cannon (ATAC) System complete with breech mechanism

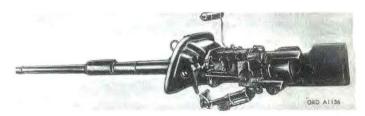
Cannon, 105 mm M68

Description

The M68 gun is basically the barrel of the British 105 mm L7 gun altered to accommodate a revised drop-block breech mechanism. One of the main changes is that the barrel is secured to the breech by a tapered pin and interrupted breech threads which allow the barrel to be removed from the tank shield without having to dismantle the mantlet. Firing is electrical only. Originally the development model of this gun was the T254E2. The M68 is being manufactured in Israel for the Merkava Mk 1 and 2, upgraded T-54/T-55, M48 and M60 series tanks in service with the Israeli Army

SPECIFICATIONS

CALIBRE 105 mm LENGTH overall 5550 mm tube 5347 mm recoil 305 mm WEIGHT complete 1128 kg 754 kg barrel BARREL LIFE 200-300 EFC



Cannon, 105 mm M68 in mount M116

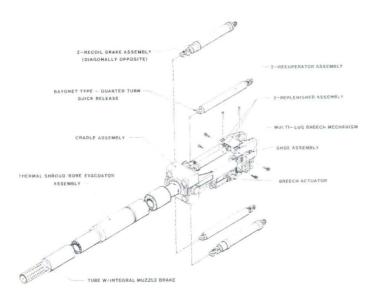
Status: Production as required. Installed in M60, M60A1 and M60A3 MBTs; Merkava MBT; M47 RKM (Israeli prototype); M48 rebuild (South Korea); Type 88 MBT (South Korean development); M1 Abrams MBT; M48A5 MBT; M48 (Spain, Israel and Iran - equivalent to M48A5).

Manufacturer: Watervliet Arsenal, USA

105 mm EX 35 Low Recoil Gun

Development/Description

The 105 mm EX 35 low recoil gun was developed by the US Army's Benet Laboratory from 1983 to meet the requirements for the Mobile Protected Gun System (MPGS) which was never funded.



Exploded view of the Benet Laboratory 105 mm EX 35 low recoil gun (US Army)

The first prototype 105 mm EX 35 Low Recoil Gun was designed and test fired within a period of 11 months. The weapon was installed in prototypes of the Light Armored Vehicle - Assault Gun (LAV - AG) (8 × 8) and will be installed in prototypes of the FMC Armored Gun System currently under development for the US Army.

No 1 gun weighed only 1270 kg and achieved a 22 per cent reduction in impulse using a 35 per cent efficient integral pepperpot muzzle brake. Both 559 and 762 mm recoil lengths have been tested, with the shorter of these being preferred when the weapon is in the LAV - AG.

Three prototype mounts and four guns were built initially with two of the latter being fitted with horizontal and two with upward opening breech mechanisms.

For the LAV - AG competition a further four models were built which all had a downward opening breech mechanism. These all have Benet's own design of a multi-lug breech which is claimed to offer significant savings in breech weight for no loss in fatigue life.

The 105 m EX 35 has small-diameter recoil and recuperator cylinders with the individual cylinders having bayonet fixings to facilitate field replacement.

Late in 1991, the US Marine Corps informed Cadillac Gage that it was terminating research and development of the Light Armored Vehicle - 105 due to lack of production funds between FY93 and FY96.

SPECIFICATIONS

CALIBRE	105 mm
WEIGHT	
complete	1325 kg
breech mechanism assembly	281 kg
mount	375 kg
gun tube	613 kg
thermal sleeve/fume extractor	51 kg

Status: Prototypes. Not yet in production or service.

Manufacturer: When placed in production it will be made at Watervliet Arsenal, USA.

FMC Cannon - Calibre Electromagnetic Launcher (CCEML)

Development/Description

FMC is under contract to design, fabricate and test a rapid-fire Cannon - Calibre ElectroMagnetic (EM) Launcher (CCEML). This will demonstrate weapon level performance while minimising weight and volume. The CCEML will be compatible with the US Marine Corps current and future amphibious assault vehicles.

The \$10.1 million contract was awarded late in 1992 by the US Army's Armament Research, Development and Engineering Center (ARDEC), and is jointly sponsored by the US Army and Marine Corps.

FMC is responsible for autoloader development and overall demonstrator system integration. The Center for Electromechanics at the University of Texas will develop the EM barrel and prime power/energy storage subsystem while Kaman Sciences Corporation will develop the integrated launch package.

Single-shot, multi-shot, and multi-salvo firings at ranges of up to 3 km are planned. In addition, FMC will also evaluate feasibility of incorporating CCEML into the Army's Bradley Fighting Vehicle and the unfunded Future Infantry Fighting Vehicle.

SPECIFICATIONS (CCEML)

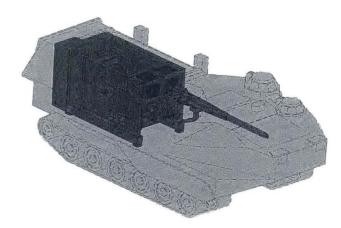
 MUZZLE VELOCITY
 1850-2150 m/s

 BORE SIZE
 20-40 mm

 FIRING RATE
 300-400 rpm

 SALVO SIZE
 5-7 rds

 SYSTEM WEIGHT
 2268 kg



Concept drawing of the Cannon Calibre Electromagnetic Launcher module mounted in the current Amphibious Assault Vehicle (AAV7A1)

Status: Under development for US Army ARDEC in conjunction with the US Marine Corps.

Research/Developer: FMC Corporation, Naval Systems Division, 4800 East River Road, Minneapolis, Minnesota 55421-1498, USA.

Telephone: (612) 571 9201

Saco Defense 40 mm Mk 19 Mod 3 Machine Gun System

Development

The 40 mm Mk 19 machine gun was originally developed by the US Naval Ordnance Station, Louisville, Kentucky, in order to provide the US Navy with a suitable weapon for riverline patrol work in Vietnam.

It was designed around the high velocity 40 mm M384 grenade round. Work commenced in July 1966 with the first functioning models being completed early the following year.

The Mk 19 Mod 0 was effectively used in combat in Vietnam. A product improvement programme, initiated by the Navy in 1970-71, resulted in the Mk 19 Mod 1 version and some 600 of the original Mod 0 version being converted to this improved specification.

In 1974 the Naval Ordnance Station resumed production, making 605 Mod 1 weapons for Israel, and these were subsequently used by the Israeli forces on ground, vehicle and boat mountings.

In 1976 Louisville began a further improvement programme aimed at improving reliability and safety, reducing cost and simplifying maintenance. The resulting Mod 3 has 47 fewer parts and can be stripped without the need for special tools.

A contract for production of the Mk 19 Mod 3 weapon and the Mk 64 Mod 4 mount was awarded by the US Government to Saco Defense Incorporated in October 1983. This and a subsequent contract awarded in December 1988 provides for deliveries of the weapon and mounts to the US Army, Air Force, Marine Corps and Navy through the early 1990s.

Description

The Mk 19 is an air-cooled, blowback type automatic machine gun that fires a variety of 40 mm grenades at a muzzle velocity of 241 m/s. These include the M430 high explosive dual purpose anti-personnel and armour-piercing round, the M918 flash bang practice round and the M385 target practice round. With a maximum effective range exceeding 1500 m, it can be used to engage personnel and light armoured vehicles. The system can be ground, vehicle or turret-mounted.

Ammunition is belted by a unique link that stays with the cartridge case and is ejected with the case after firing. The gun is fired from the open bolt position with the ammunition feed occurring during recoil, similar to the M2 12.7 mm machine gun.

It can be fired manually or remotely by use of an electrical solenoid, a single round at a time or fully automatic at 325 to 375 rds/min.

The Mk 19 is comprised of five major subassemblies: the bolt and backplate; seat; top cover; feed slide and tray; and receiver. It is fitted with a sight, spade grips, and charger assembly similar to those on the 12.7 mm M2 machine gun.

A variety of fire control systems and mounts are available to enhance the capabilities of the Mk 19. Day and night sights, laser aiming devices and laser rangefinders are attached and detached from a weapons bracket, without the loss of boresight, by using the US Army's dovetail configuration and advanced throw lever attachment device.

The Mk 19 can be mounted on virtually any vehicle, boat or helicopter using the Mk 64 and stainless steel MSG H19 Carriage and Cradles, round mounts and pedestals. It can also be mounted in a turret, such as the US Marine Corps 40/50 turret. Examples of vehicles on which the Mk 19 is mounted are the HMMWV, Chenowth Fast Attack Vehicle, M113 APC, Land Rover and US Marine Corps AAV7A1 amphibious vehicle.

SPECIFICATIONS

 CALIBRE
 40 mm

 WEIGHT OF GUN
 35.3 kg

 LENGTH OF GUN
 1095 mm

 HEIGHT OF GUN
 206 mm

 MUZZLE VELOCITY
 241 m/s

 MAX EFFECTIVE RANGE
 1500 m

 RATE OF FIRE
 325-375 m

RATE OF FIRE 325-375 rpm (cyclic)
MOUNTINGS turret, pedestal or tripod



Saco Defense 40 mm Mk 19 Mod 3 machine gun system complete with ammunition box and tripod

AMMUNITION

40 mm M918 flash-bang, M430 HE dual purpose and M385 target practice

Status: Production. Adopted by Ecuador, Honduras, United Kingdom and United States.

Manufacturer: Saco Defense Incorporated, 291 North Street, Saco, Maine 04072, USA.

Telephone: (207) 283 3611 Telex: 944-408 Fax: (207) 282 6462

McDonnell Douglas 35 mm/50 mm Bushmaster III Automatic Cannon

Development/Description

In October 1989, the McDonnell Douglas Helicopter Company announced that it was developing, as a private venture, a new range of weapons that capitalises on technology developed for the 25 mm M242 Chain Gun Cannon currently in service with Spain and the United States Army, Navy and Marine Corps.

The largest of these weapons is the 35 mm/50 mm Bushmaster III Automatic Cannon which can fire 35 mm or 50 mm ammunition with minor modifications, including a barrel change. The first weapon was fired in May 1990 using Oerlikon-Contraves 35 mm ammunition.

The 35 mm/50 mm Bushmaster III automatic cannon will have ammunition interoperability with the German Rheinmetall 35 mm/50 mm cannon also under development.

SPECIFICATIONS

 CALIBRE
 35 mm/50 mm Super Shot

 MUZZLE VELOCITY
 1400 m/s (35 mm APFSDS)

 1600 m/s (50 mm Super Shot)

751.84 mm

LENGTH

 overall
 4015.74 mm

 WIDTH
 358 mm

 HEIGHT
 409 mm

 LENGTH
 409 mm

behind front of feed

WEIGHT

 receiver assembly
 68 kg

 barrel assembly
 107 kg

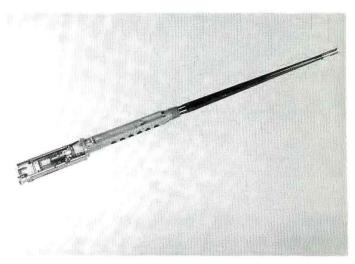
 feeder assembly
 29.5 kg

 TOTAL GUN ASSEMBLY
 204 kg

RATE OF FIRE single shot, 200 or 350 rds/min

PEAK RECOIL 6350 kg
POWER REQUIREMENTS 3 bp. (20

POWER REQUIREMENTS 3 hp (200 rds/min) 8 hp (350 rds/min)



35 mm/50 mm Bushmaster III Chain Gun automatic cannon developed by McDonnell Douglas Helicopter Co

CLEARING METHOD

(cook-off safe) open bolt CASE EJECTION forward

Status: By early 1993, one prototype of this weapon had been built and was undergoing company trials.

Manufacturer: McDonnell Douglas Helicopter Company, 5000 East McDowell Road, Mesa, Arizona 85205, USA.

Telephone: (602) 891 7007 Telex: 182435 MD HC ORD MESA

Fax: (602) 891 8758

McDonnell Douglas 40 mm Bushmaster IV Automatic Cannon

Development/Description

Late in 1991, McDonnell Douglas Helicopter Company announced that it was developing, as a private venture, a new 40 mm weapon called the Bushmaster IV based on its extensive experience with the Chain Gun family of weapons.

The 40 mm Bushmaster IV will have the same method of operation as the earlier Chain Gun Cannon with forward case ejection and two rates of fire, single shot or 200 rds/min.

It will fire ammunition originally developed by Bofors for the 40 mm L/70 cannon installed in the new Combat Vehicle 90 ordered by the Swedish Army in early 1991.

The company is offering the larger calibre Chain Gun Cannon for the upgrading of existing vehicles or for installation in new vehicle designs.

44 WEAPONS OF 20 mm AND UPWARD / USA

SPECIFICATIONS	
CALIBRE	40 mm
LENGTH (overall)	3835 mm
WIDTH	378 mm
HEIGHT	419 mm
LENGTH (behind front of feed)	925 mm
WEIGHT	
receiver assembly	83.9 kg
barrel assembly	138 kg
feeder assembly	38.55 kg

RATE OF FIRE single shot, 200 rpm
PEAK RECOIL 635 kg
POWER REQUIRED 4.5 hp
CLEARING METHOD open bolt
CASE EJECTION integral linkless

Status: Development.

Manufacturer: McDonnell Douglas Helicopter Company, 5000 East

McDowell Road, Mesa, Arizona 85205, USA.

Telephone: (602) 891 7007 Telex: 182435 MD HC ORD MESA

Fax: (602) 891 8758

McDonnell Douglas 30 mm M230 Chain Gun Automatic Cannon

260.8 kg

Description

TOTAL GUN ASSEMBLY

As with other forms of the McDonnell Douglas Helicopter Company's Chain Gun family, all the movements and timings of the 30 mm M230 are propelled and timed by an external power source and a single drive chain. The original XM230 model was produced in three versions. The A Model was the trial prototype which underwent a 2500-round feasibility test with the US Army in July 1973. Some detail shortcomings were revealed by these tests and the resultant B Model was extensively tested during 1974. The C Model uses linkless ammunition for installation on the McDonnell Douglas Helicopter AH-64 Apache Attack Helicopter. The M230 has been designed to accommodate various forms of 30 mm ammunition including the 30 mm ADEN, DEFA and American M789 and M799. Both linked and linkless ammunition may be used, depending on the installation.

In addition to the aircraft role, the M230 has been installed and fired from several lightweight wheeled vehicles to demonstrate feasibility for potential scout and reconnaissance applications.

SPECIFICATIONS

SPECIFICATIONS	
CALIBRE	30 mm
LENGTH	1676 mm
HEIGHT	290 mm
WIDTH	267 mm
WEIGHT	
receiver (includes motor)	38 kg
barrel	14.5 kg
recoil adapter	5 kg
linkless transfer unit	3.7 kg
total gun weight	59 kg

 BARREL LIFE (approx)
 20 000 rounds

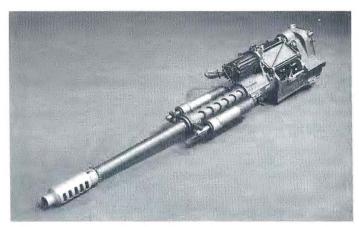
 TIME TO RATE
 0.2 s

 TIME TO STOP
 0.1 s

Status: In production. In service with US Army in helicopter application with over 750 delivered by late 1992. The AH-64 has also been ordered by Egypt, Greece, Israel, United Arab Emirates and Saudi Arabia.

Manufacturer: McDonnell Douglas Helicopter Company, 5000 East

McDowell Road, Mesa, Arizona 85205, USA. Telephone: (602) 891 7007 Telex: 182435 MD HC ORD MESA Fax: (602) 891 8758



McDonnell Douglas Helicopter Co 30 mm M230 Chain Gun

Combat Vehicle Armament Technology (COMVAT)

625 ± 25 rds/min

Development/Description

RATE OF FIRE (cyclic)

The Combat Vehicle Armament Technology (COMVAT) programme is being carried out under the sponsorship of the US Army Armament Research and Development Center (ARDEC) with Alliant Techsystems as the prime contractor. With the aim to develop a system for application to the Bradley Fighting Vehicle Block Mod III, Future Infantry Fighting Vehicle and similar combat vehicles, it offers superior range, penetration, stowed ammunition load and integration features over current weapon systems.

By 1989 COMVAT had been demonstrated successfully in 30 mm calibre with 45 mm COMVAT demonstrated in November 1990 and August 1991.

Alliant Techsystems, prime contractor for COMVAT, is also responsible for ammunition development, ARES is responsible for the XM295 45 mm

automatic cannon, FMC for vehicle installation and fire control and Western Design for the feed and storage system.

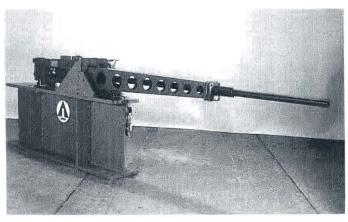
A new family of cased telescoped ammunition has been developed including APFSDS-T XM978 with a low dispersion that will defeat advanced armours, HEI-T XM979 with impact fuzing and insensitive explosives and TP-T ballistic test rounds. Future rounds include TPDS-T matched to APFSDS-T round, TP-T matched to HEI-T round and an HEI-T round with remote set fuze.

The dual feed 45 mm ARES cannon is recoil operated with a rotating chamber and can fire up to 200 rds/min (cyclic). An advanced linkless feed system is incorporated that feeds through the cannon trunnion.

COMVAT builds on the experience obtained with the earlier CVAST (Combat Vehicle Armament System Technology) testbed which was under the overall direction of the Fire Control and Small Calibre Weapon Systems Laboratory of ARDEC. This involved a two-man power-operated turret armed with a 35 mm ARES Talon cannon and a 7.62 mm coaxial machine gun. The turret was tested on an FMC Bradley and an M113A2 chassis.



Artist's impression of COMVAT showing position of 45 mm cannon and feed system



Prototype of the ARES 45 mm XM295 automatic cannon

Status: System demonstration in FY90 and FY91. Continuing contract work in FY93. Late in 1992 an agreement was signed between Alliant Techsystems and Giat Industries of France on future co-operation. Details are given in the Giat 45 mm CTA entry under France.

Manufacturer: Alliant Techsystems, 7225 Northland Drive, Brooklyn Park, Minnesota 55428, USA (prime contractor). Telephone: (612) 536 4544 Fax: (612) 536 4545

McDonnell Douglas 30 mm Bushmaster II **Automatic Cannon**

Development/Description

In October 1989, the McDonnell Douglas Helicopter Company announced that it was developing, as a private venture, a new range of weapons that capitalise on technology developed for the 25 mm M242 Chain Gun Cannon currently in service with Australia, Spain and the United States Army, Navy and Marine Corps.

The prototype of the 30 mm Bushmaster II automatic cannon was completed in mid-1989 and by October of that year had fired over 500 rounds and was then demonstrated in Austria followed by a US Navy 2000

Some 70 per cent of the parts of the new 30 mm Bushmaster II weapon are identical to the current 25 mm M242 cannon and the gunner can select one of three rates of fire, with the maximum being 400 rds/min.

In addition to offering the 30 mm Bushmaster II to the United States Army for installation in the Bradley IFV, it could also be fitted to the future United States Marine Corps Advanced Amphibious Assault Vehicle (AAAV) or the US Navy's Advanced Minor Calibre Gun Mount.

The 30 mm Bushmaster II fires standard US GAU-8 30 × 173 mm ammunition using a side-stripping link developed by McDonnell Douglas or, by changing the barrel, bolt and rear feed plate, British 30 \times 170 mm RARDEN or Oerlikon-Contraves ammunition.

Bushmaster II is also a candidate weapon for the Austrian, Norwegian and Swiss new combat vehicle programmes.

SPECIFICATIONS

30 mm
1036 m/s
1219 m/s
3500 mm
335.28 mm
396.24 mm
622.3 mm
49.89 kg
68.04 kg
29.48 kg



McDonnell Douglas Helicopter 30 mm Bushmaster II cannon installed in Bradley IFV

TOTAL GUN ASSEMBLY 147.42 kg RATE OF FIRE single shot, 200 or 400 rpm PEAK RECOIL 5443 kg 1.5 hp (200 rds/min) POWER REQUIREMENT 8 hp (400 rpm) CLEARING METHOD open bolt CASE EJECTION forward

Status: Development complete. Ready for production. In addition to the two initial firing prototypes, the company has built productionised Bushmaster Il weapon systems which were completed in 1992.

Manufacturer: McDonnell Douglas Helicopter Company, 5000 East

McDowell Road, Mesa, Arizona 85205, USA.

Telex: 182435 MD HC ORD MESA Telephone: (602) 891 7007

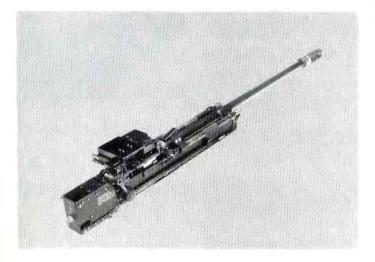
Fax: (602) 891 8758

McDonnell Douglas 30 mm ASP-30 Combat Support Weapon

Development

The 30 mm ASP-30 Infantry Support Weapon has been developed as a private venture by McDonnell Douglas Helicopter Company and was first shown in public during the October 1984 AUSA exhibition held in Washington. Development of the ASP-30 began in mid-1984 and the weapon fired its first rounds at McDonnell Douglas Helicopters' Culver City range in October 1984

The name ASP-30 is derived from Automatic Self-Powered with 30 being the calibre of the weapon in mm. By mid-1989 three prototypes had been



built and fired over 20 000 rounds of ammunition. These three prototypes were followed by a batch of development weapons.

In the Spring of 1989 Royal Ordnance and McDonnell Douglas Helicopters signed an agreement under which Royal Ordnance has exclusive sales and marketing rights throughout the world with the exception of Argentina, Israel and the United States. The latter countries remain the responsibility of McDonnell Douglas Helicopters. A 20 000-round firing test on the current model is being conducted.

Description

The gas-operated weapon has built-in dual-acting recoil adaptors, a rotating bolt mechanism and a blast suppressor. It can quickly replace 12.7 mm (0.50 calibre) M2 HB machine guns and 40 mm Mk 19 high velocity grenade launchers mounted on armoured vehicles and can also be mounted on the standard M3 heavy machine gun tripod for use in the ground fire suppression role. It can also be installed on the US Navy Mk 16 Deckmount for naval use. Another potential application for the ASP-30 is a helicopter

The gunner can fire semi-automatic or full automatic and the short recoil travel allows the gunner to fire the weapon using the spade grips

The ASP-30 fires standard 30 × 113B mm ammunition already in production for the McDonnell Douglas Helicopter including M789 High Explosive Dual Purpose (HEDP), M788 Target Practice (TP) and M799 High Explosive Incendiary (HEI). All these rounds have a muzzle velocity of 823 m/s. The M789 HEDP round has a maximum range of 4000 m and can defeat the BMP ICV at combat ranges. The weapon can also fire ammunition used by the French 30 mm DEFA and British 30 mm ADEN Mk IV weapons.

For its first public demonstration it replaced the standard 12.7 mm M2 HB machine gun on an M113A2 APC and hit stationary targets at ranges up to 1000 m.

SPECIFICATIONS

CALIBRE 30 mm LENGTH 2027 mm overall barrel with blast suppressor 1473 mm barrel without blast suppressor 1321 mm behind rear of feed 292 mm DIRECTION OF FEED left hand WIDTH 203 mm HEIGHT 241 mm WEIGHT 52 kg RATE OF FIRE semi-automatic or LOCKING MECHANISM METHOD OF OPERATION RECOIL ADAPTER DIRECTION OF FEED MOUNTING PROVISIONS rotating bolt gas, straight expansion type built-in, dual-acting left hand as M2 HB

Status: Pre-production. The ASP-30 has been demonstrated in Europe, US and the Middle East.

Manufacturer: McDonnell Douglas Helicopter Company, 5000 East

McDowell Road, Mesa, Arizona, 85205, USA.
Telephone: (602) 891 7007 Telex: 182435 MD HC ORD MESA

Fax: (602) 891 8758

McDonnell Douglas 25 mm M242 Bushmaster Cannon

400/450 rds/min

Development/Description

The basic principle of the Chain Gun weapon is that all the various moving parts are operated and timed by a single conventional industrial double-row roller chain which cycles in an oval pattern on four sprockets: three idlers and one driven. All the movements and timings can thus be timed precisely and the weapon is entirely independent of ammunition variations.

The M242 Bushmaster Cannon, part of the Chain Gun family, was developed specifically for ground vehicles although it has been adapted to several naval deck gun installations. It has a single barrel fitted with a muzzle brake, and uses an integral dual feed with remote feed selection. The recoil mechanism is fully internal and spent cases are ejected forwards from the gun. Like other members of the Chain Gun Cannon family it is externally powered.

The first US Army request for a gun that led to the M242 was made in September 1975. In February 1976 Hughes Helicopters (now the McDonnell Douglas Helicopter Company) was awarded a 24-month development contract worth \$5 612 000 and a prototype was under test 10 months later. The weapon was type classified as the M242 in February 1980 and eventual production is expected to exceed 14 000, and the type has been selected by the US Navy on patrol boats and auxiliary ships. US Navy

purchases, expected to number several hundred, are made through US $\mbox{\sc Army channels.}$

In 1986 McDonnell Douglas Helicopter Company was awarded a five year sole source contract for the delivery of 3956 additional cannon through to 1991 with a total value of \$150.3 million.

By the Spring of 1991 the company had delivered over 7300 25 mm M242 Chain Guns and by December 1991 the total order book was for 8975 weapons. Options, if exercised, would continue US military production through to 1995.

In addition, McDonnell Douglas Helicopters has delivered 124 25 mm M242 Chain Guns plus spares for Swiss MOWAG armoured vehicles being built for the Saudi Arabian Ministry of Defence and Aviation.

In early 1987 Spain placed a contract worth \$9 million for 208 M242 cannon to arm the Pegaso VEC (6×6) Cavalry Scout vehicle. The first unit was delivered in April 1987. The cannon had been mounted in T 25 two-man turrets built by SANTA BARBARA under licence from OTO Melara. Final deliveries of the M242 to Spain were made in September 1989.

Saudi Arabia has ordered 400 M2/M3 Bradley vehicles which will be armed with a 25 mm McDonnell Douglas Helicopters M242 Chain Gun.

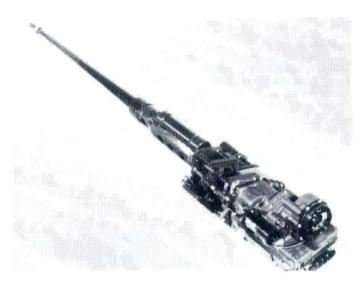
The standard M242 has a cyclic rate of fire of 200 rds/min, and only five parts have to be changed to convert the weapon to a cyclic rate of fire of 500 rds/min, clutch, sear solenoid, index drive cover, cluster gear and motor. A 500 rds/min control unit, gun drive cable and control cable will also be required, unless these are incorporated within the turret control system.

SPECIFICATIONS		WEIGHT		TIME TO RATE	0.15 s
CALIBRE	25 mm	complete	110.5 kg	TIME TO STOP	0.12 s
LENGTH		receiver assembly	40.8 kg	POWER REQUIRED	
overall	2760 mm	barrel assembly	43 kg	for 200 rds/min	1.5 hp
behind front of feed	533 mm	feeder assembly	26.7 kg	for 500 rds/min	8 hp
barrel	2032 mm	RATE OF FIRE (cyclic)	100, 200 or 500 rds/min	DISPERSION	0.5 mil
HEIGHT	380 mm		and single shot	RELIABILITY	
WIDTH	330 mm	BARREL WEAR	surpasses life	DEMONSTRATED	more than 20 000 MRBF
			requirements		

Status: In production. Installed on M2 and M3 Bradley Fighting Vehicles (in service with US Army and Saudi Arabia) and US Marine Corps Light Armored Vehicle (LAV-25), (in service with Australia and United States Marine Corps) also installed for trials purposes on Alvis Stormer, Cadillac Gage V-300 and V-150s and MOWAG Piranha vehicles; one- and two-man turrets; SAMM TTB 125 turret on Panhard ERC, Fox, Dragoon 300; VEC Cavalry Vehicle (in service with Spain); GKN Defence Savasci; Mk 38 naval deck mount; Creusot-Loire T25H turret; AM General HMMWV. In early 1990 the T25H turret was installed onto the prototype of the IFV version of MARS 15. It is also fitted in the Delco two man turret installed on Desert Warrior selected by Kuwait in 1992. The 8000th M242 cannon was delivered in September 1992.



VEC (6 \times 6) vehicle of the Spanish Army fitted with two-man OTO Melara turret armed with 25 mm M242 Chain Gun Cannon



25 mm M242 Bushmaster Cannon

Manufacturer: McDonnell Douglas Helicopter Company, 5000 East McDowell Road, Mesa, Arizona, 85205, USA.

Telephone: (602) 891 7007 Telex: 182435 MD HC ORD MESA

Fax: (602) 891 8758

YUGOSLAVIA (Serbia/Montenegro)

GAS PRESSURE

RECOIL FORCE

30 mm M86 Cannon

Development/Description

This weapon is of Yugoslav design and manufacture and is intended for installation in tracked and wheeled armoured fighting vehicles as well as anti-aircraft systems. The 30 mm M86 weapon is installed in the Yugoslav BVP M80AK infantry fighting vehicle, the latest version of the BVP M80 series.

The M86 is a gas-operated belt-fed cannon that can be feed from either side with the spent cartridge cases being ejected forwards. It has an integral gas buffer and spring recuperator which reduces the recoil load on the mounting.

The barrel can be easily removed or replaced, and the feed system is powered by recoil energy and is capable of lifting a 40-round length of belt. Belt cocking and sear release are both performed by hydraulic

mechanisms and firing is controlled by a 24 V electric circuit.

Variant

There is a separate entry for the 30 mm M89 cannon which is based on the

SPECIFICATIONS

CALIBRE	30 mm
AMMUNITION	30 × 192 mm
OPERATION	gas, automatic
FEED	belt
WEIGHT	205 kg
BARREL WEIGHT	60 kg



30 mm M86 cannon showing ammunition fed from right side

 LENGTH OVERALL
 3065 mm

 BARREL LENGTH
 2100 mm

 HEIGHT
 264 mm

 WIDTH
 242 mm

 RIFLING
 12 groove

12 grooves, right hand, increasing

twist to 6°24' 300 MPa 25 kN

 MAX RECOIL DISTANCE
 45 mm

 MUZZLE VELOCITY
 1050 to 1120 m/s

 RATE OF FIRE (cyclic)
 550 to 650 rpm

 AMMUNITION TYPES
 HEI, HEI-T, AP, practice and practice T

Status: In service with Yugoslav Army.

Contractor: SDPR, Zavodi Crvena Zastava. Enquiries to Federal Directorate of Supply and Procurement, PO Box 308, 9 Nemanjina Street, Belgrade, Yugoslavia.

Telephone: 621 522 Telex: 11360 Fax: 635 702



30 mm M86 cannon stripped down to show main components: (1) breech casing, (2) barrel assembly, (3) front seat, (4) rear seat, (5) breech block, (6) buffer, (7) trigger mechanism, (8) recoil rake and recuperator mechanisms, (9) lower feeder, (10) upper feeder, (11) gas piston. (12) shock absorber, (13) barrel support and (14) link chute

30 mm M89 Cannon

Development/Description

This 30 mm cannon operates on the same principle and has the same component parts as the 30 mm M86 cannon covered in the previous entry. They differ only in that the M89 has a dual feed system.

This cannon is equipped with a dual feeder with direct ammunition change over (second round response) with the feed system being powered by recoil energy.

SPECIFICATIONS

(all other specifications are identical to the 30 mm M86 cannon)

Status: In service with Yugoslav Army.

Contractor: SDPR, Zavodi Crvena Zastava. Enquiries to Federal Directorate of Supply and Procurement, PO Box 308, 9 Nemanjina Street. Belgrade. Yugoslavia.

Telephone: 621 522 Telex: 11360 Fax: 635 702



30 mm M89 cannon showing dual feed system

List of Coaxial Machine Guns

Note: Full descriptions of most of the machine gun types mentioned in the list will be found in the Machine Guns section of *Jane's Infantry Weapons 1993-94*. Additional details of Belgian FN 7.62 mm GPMG, FN 12.7 mm M2 HB (QCB) and Saco Defense 7.62 mm M60E2 machine gun are provided for reference purposes.

Country	Weapon	Cyclic rate of fire per minute	Effective range (m)
Austria	7.62 mm MG74	n/av	1000
Belgium	7.62 mm MAG	650-1000	1500
Belgium	5.56 mm Minimi	750-1000	400
China, People's Republic	7.62 mm Type 59T	650	1000
France	7.5 mm Model F1	700	800
Germany	7.62 mm MG3	700-1300	1000
Italy	7.62 mm MG42/59	800	1000
Japan	7.62 mm Type 74	700-1000	1000
Switzerland	7.5 mm Model 87	700-1000	1200
Former USSR	7.62 mm PKT	650	1000
Former USSR	7.62 mm SGMT	650	1000
Former USSR	7.62 mm DTM	600	1000
UK	7.62 mm L8A1/2	625-750	1000
UK	7.62 mm L37A2	625-750	1000
UK	7.62 mm L43A1	625-750	1000
UK	12.7 mm L21A1	400-600	1800 or
	Browning		2500
USA	0.30 in L3A3,	400-500	1000
	M37, M1919A4,		
	M1919A5		
	Browning		
USA	0.50 in M2	500-800	1000
	Browning		
USA	7.62 mm M60E2	550	1000
USA	7.62 mm M73	500-625	1000
USA	7.62 mm M219	500-625	1000
USA	0.50 in M85	400 (low)	1000
W12-17		1050 (high)	
USA	7.62 mm EX-34 Chain Gun	570	1000

Typical Coaxial MG Vehicle Fits:

WEAPON	AFV INSTALLATION
7.62 mm MG74	SK 105 tank destroyer
7.62 mm MAG	Leopard 1 (Dutch) MBT, TAM MBT, Merkava MBT, M60A1/3 MBT (as M240), M1/M1A1/M1A2 Abrams MBT (as M240), Stingray light tank (as M240), M2/3 Bradley IFV (as M240), Jagdpanzer Kanone (Belgian) tank destroyer
7.62 mm Type 59T	Type 69 MBT
7.62 mm MG3	Leopard 1 MBT, Leopard 2 MBT, Jagdpanzer Kanone tank destroyer, Marder 1 ICV, M47E2 MBT (Spain)
7.62 mm MG42/59	VCC 80 ICV
7.62 mm Type 74	Type 74 MBT
7.5 mm Model 87	Pz 61 MBT, Pz 68 MBT
7.62 mm PKT	T-62 MBT, T-72 MBT, T-80 MBT, BMP-1, BMP-2 and BMP-3 MICV, BMD-1/BMD-2/BMD-3 ACV, BRDM-2 reconnaissance vehicle, TAB-C reconnaissance vehicle, PSZH-IV APC, TAB-72 APC, TAB-77 APC, OT-64 SKOT-2AP APC, OT-62 TOPAS-2-AP APC, BTR-60PB/70/80 APC
7.62 mm SGMT	T-54/55 MBT, ASU-85 tank destroyer
7.62 mm DTM	T-34 medium tank, PT-76 light amphibious reconnaissance tank
7.62 mm L8A1	Chieftain MBT
7.62 mm L8A2	VFM Mk 5, Challenger 1 MBT, Khalid MBT, Chieftain MBT
7.62 mm L37A2	Fox reconnaissance vehicle, Scimitar reconnaissance vehicle, Scorpion reconnaissance vehicle
7.62 mm L43A1	Scorpion reconnaissance vehicle as ranging MG
12.7 mm L21A1	Vickers Mk 1 MBT, Vickers Mk 3 MBT, Chieftain MBT (non-British), Centurion MBT as ranging MG
0.30 in Browning L3A3, M37	Type 61 MBT (Japan, M1919A4), M4 Sherman medium tank, M41 light tank, M47 MBT (M1919A4), M48/M48A1 MBT (M1919A4E1), M48A2 MBT (M37), Centurion MBT (L3A3), M3 light tank (M1919A5), Saladin armoured car (L3A3)
0.50 in Browning 7.62 mm M60E2 7.62 mm M73 7.62 mm M219 7.62 mm EX-34 Chain Gun	M47 MBT (M2E1), NM-116 light tank (Norway) Type 88 MBT (South Korea), M48A5 MBT M48A3 MBT, M60A1/A3 MBT M48A3 MBT, M60A1/A3 MBT Warrior MICV, Challenger 2 MBT

BELGIUM

FN 7.62 mm GPMG

SPECIFICATIONS

LENGTH

WEIGHT

CALIBRE 7.62 mm NATO

OPERATING PRINCIPLE gas operated, open breech firing,

solenoid firing 1085 mm 10.375 kg

EFFECTIVE RANGE 1500 m MAX BANGE 4200 m RATE OF FIRE 650-1000 rpm

Status: In production. In service with many countries in a wide range of roles including bipod and tripod for infantry fire support, armoured fighting vehicle and air defence applications.

Manufacturer: FN Herstal, 33 Voie de Liege, B-4040 Herstal, Belgium. Telephone: (32-41) 408111 Telex: 41223 fabna Fax: (32-41) 408679



FN Herstal's 7.62 mm coaxial machine gun showing feed from left and solenoid for firing

FN 12.7 mm M2 HB (QCB) Machine Gun

SPECIFICATIONS

CALIBRE 12.7 mm (0.50 cal)

OPERATING PRINCIPLE by short recoil of the barrel,

closed breech firing, solenoid

firing

LENGTH 1656 mm WEIGHT 38 kg **EFFECTIVE RANGE** 2000 m MAX RANGE 6800 m RATE OF FIRE 485-635 rpm

Note: FN Herstal produce two basic models of the 12.7 mm HB machine gun, standard and Quick Change Barrel (QCB). These are used for a wide range of roles including fire support, air defence and mounted as a coaxial machine gun. The latter is used with the M2 or M9 distintegrating belt and has a chrome plated barrel, has no barrel handle, feeds from the left with cocking handle on the right, left hand side cover latch, link chute, firing by means of a solenoid and manual trigger, no bolt latch or sight.

Status: In production. In service with many countries in a wide range of roles.



FN Herstal's 12.7 mm M2 HB coaxial machine gun

Manufacturer: FN Herstal, 33 Voie de Liege, B-4040 Herstal, Belgium. Telephone: (32-41) 408111 Telex: 41223 fabna Fax: (32-41) 408679

UNITED STATES OF AMERICA

Saco 7.62 mm M60E2 Machine Gun

Development/Description

The 7.62 mm M60E2 machine gun was developed by Saco Defense for installation in armoured vehicles, aircraft and boats. It is a solenoid operated weapon and 80 per cent of the components of the M60E2 are interchangeable with those of the Saco M60 General Purpose Machine Gun. A barrel extension blast tube and gas evacuator tube system carry harmful blasts and gases to the outside when used in internal applications.

SPECIFICATIONS

CALIBRE 7.62 mm NATO FEED link belt

LENGTH short barrel 1181 mm long barrel 1384 mm MUZZLE VELOCITY 853 m/s RATE OF FIRE 500-650 rpm MAX RANGE 3725 m MAX EFFECTIVE RANGE 1100 m

WEIGHT 10.2 kg short barrel long barrel 11.1 kg

Status: Production. In service with US Marine Corps.

Manufacturer: Saco Defense Incorporated, 291 North Street, Saco, Maine

04072, USA.

Telephone: (207) 283 3611 Telex: 944-408 Fax: (207) 282 6462



Saco Defense 7.62 mm M60E2 machine gun

Vehicle-Mounted Anti-Tank Guided Weapons

CHINA, PEOPLE'S REPUBLIC

NORINCO Red Arrow 8

Development/Description

Revealed in the early 1980s, the Red Arrow 8 was developed from the early 1970s and entered production in 1987. It is a second generation wire guided tube-launched Semi-Automatic Command to Line-Of-Sight (SACLOS) missile which is similar in appearance to the British Swingfire. All the gunner has to do is keep his optical sight on the target until the missile impacts. The Red Arrow 8 has not yet seen combat service.

SPECIFICATIONS

wire-guided SACLOS LENGTH 0.875 m DIAMETER 0.12 m WING SPAN 0.32 m LAUNCH WEIGHT 11.2 kg 3 kg WARHEAD 100-3000 m RANGE ARMOUR PENETRATION 800 mm 200-220 m/s

Status: In production. In service with the Chinese Armed Forces.

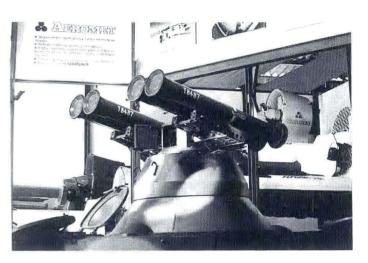
Armoured Vehicle Applications

Tracked YW531 APC (four-tube turret - Chinese Armed Forces) Tracked YW534 APC (four-tube turret - Chinese Armed Forces)

Armoured Vehicle Trial Applications

4 × 4 WZ 551 (four-round turret)

6 × 6 Cardoen/MOWAG APC (four-tube turret)



Close-up of four-round NORINCO Red Arrow 8 ATGW launcher on Chilean Cardoen/MOWAG APC (Pedro del Fierro)

Manufacturer: NORINCO, China North Industries Corporation, 7A, Yuetan Nanjie, Beijing, People's Republic of China.

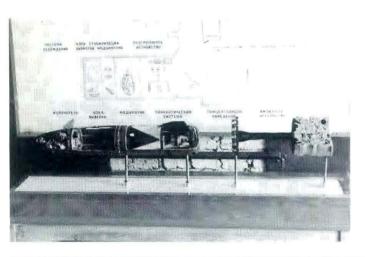
Telephone: (86) 6898/3461/3471/7570 Telex: 22339 CNIN CN

COMMONWEALTH OF INDEPENDENT STATES

AT-11 Sniper

Development/Description

The NATO designated AT-11 (industrial index number 9M119, named Svir. meaning shawm - a double-reeded wind instrument resembling the oboe) is a two-part 125 mm calibre laser beam-guided projectile for use with the



125 mm tank guns used in the T-80U, T80UD, T72B1, T-72S and T72S1 MBT variants. The complete beam riding missile system has the industrial index number 9K120

The laser beam guidance subsystems are incorporated into the tank's standard fire control system and is thought to operate on the same principles as those described for the AT-10 Bastion (qv). The missile is estimated to travel at over Mach 2, which allows it to hit targets at its maximum 4000 m engagement range after only some five seconds of flight. A shaped charge is incorporated into the projectile as the warhead. A separate booster charge is loaded into the gun with the missile to act as the ejector upon firing. Standard combat load for the tanks is six AT-11.

Status: Production. In service with the CIS and possibly some other countries.

Armoured Vehicle Applications

T-72S1 MBT (125 mm gun/missile launcher - possibly small numbers to favoured export customers)

T-72B1 MBT (125 mm gun/missile launcher - CIS Armies)

T-72S MBT (125 mm gun/missile launcher - possibly small numbers to several favoured export customers)

T-80U MBT (125 mm gun/missile launcher - CIS Armies)

T80UD (125 mm gun/launcher and 1K13 sight - CIS Armies).

Manufacturer: State factories.

Complete AT-11 missile and booster section (right)

AT-10 Stabber

Development/Description

The NATO designation AT-10 (industrial index number 9M117, name Bastion, meaning a bastion) entered service around 1985 and is a singlepiece 100 mm calibre laser beam-guided projectile for use with the 100 mm tank gun of the T-55 medium tank and the 100 mm rifled gun of the BMP-3 ICV. It should be noted that T-55 tanks built to the AT-10 system configuration have been fitted with the Kladivo fire-control system first.

T-55 variants known to be fitted with the system include: T-55AM2P, -55AMV, T-55AM2B (produced in the former Czechoslovakia) and T-55AM2P (produced in Poland).

The principle components of the 9K116 beam riding missile system for the equipped tanks are:

- (1) the 3UBK10-1 guided round (comprising the 9M117 missile mounted within a cartridge case)
- (2) an onboard vehicle guidance system comprises:

(a) a 1K13 day/night telescopic sight (with integral 1K13BZ laser emitter) to replace the T-55 series standard TPN-1M-22-1 telescopic IR sight. The sight is vertically stabilised with its line-of-sight slaved to the stabilised 100 mm gun for the target acquisition phase.

For an engagement the sighting system is activated to switch the main armament stabilisation system off and reduce the maximum turret traverse speed down so as to avoid any distortion effects. After the system ready sign comes on the gunner can fire the missile.

The 9M117 is fired electrically as in the case of the standard 100 mm ammunition types. The missile's built-in battery is started and the gyroscope run-up. After 1.5 seconds an ejection charge in the cartridge is ignited and the missile leaves the barrel. Then, after the base has been jettisoned, the four rear-mounted aerodynamic stabilising fins are unfolded. The four forward-mounted control fins are also deployed. The sustainer rocket motor cuts in and burns for approximately six seconds.

After the firing the commander's laying device is turned off and the laser activated to emit the modulated IR laser guidance beam. The missile flies automatically within a guidance zone formed by this projected beam. All the gunner has to do during the remainder of the engagement is to keep his sight on the target until the missile has impacted.

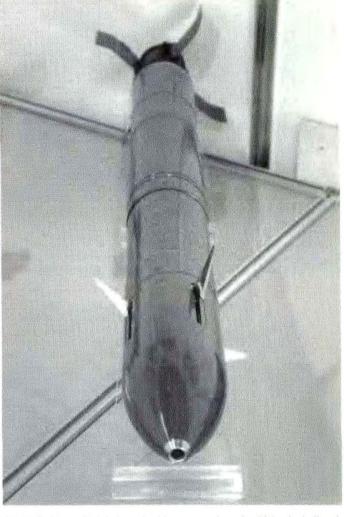
During the whole of the semi-automatic guidance phase the sightline is independently stabilised from the gun in both azimuth and elevation. A modulator encodes the laser beam in such a fashion that each reference point of the guidance zone is given a precisely timed sequence of frequencies. The correlation between the duration of the different frequencies is determined by the position of each point within the guidance zone.

The 6 m diameter of the guidance zone is kept constant throughout the flight by progressively zooming the beam. A receiver in the rear section of the missile transmits information on the flight position within the guidance zone to the onboard guidance system which then transmits flight control commands to the four forward-mounted flip-out control surface fins. The 9M117 is aerodynamically stabilised by its four rear-mounted pop-up stabilisers

- a 9S381 voltage converter unit
- a modified STP-2A stabilisation system (to replace the standard (c) STP-2 system)
- an L4 IR searchlight to replace the L-2G type When the tank is static the system can be used to engage moving and stationary targets, static positions or slow moving aerial targets. Effective engagement limits are stated to be from 100 to 4000 m, with the weapon having a flight time of 12 seconds to the latter range. In the case of a miss a self destruct device automatically destroys the shaped charge warhead within 26 to 41 seconds of firing. Missile weight without its cartridge is 26.8 kg.

The same general engagement scenario is believed to occur with the BMP-3 ICV AT-10 system. Standard combat load for both the T-55 and BMP-3 is six AT-10. The larger 125 mm calibre AT-11 Svir system is also believed to operate on the same guidance principles (qv)

Status: Production. In service with the former Soviet Union and possibly some other countries.



AT-10 Stabber which is launched from a number of vehicles including the 100 mm gun installed in the BMP-3 (Christopher F Foss)

Armoured Vehicle Applications

T-55 medium tank (100 mm gun/missile launcher - CIS Armies, Naval Infantry and other unspecified countries)

BMP-3 ICV (100 mm gun/missile launcher and 1K13 sight - CIS Armies, Abu Dhabi).

Manufacturer: State factories.

AT-8 Songster

Development/Description

The NATO designated AT-8 Songster (industrial index number 9M112, named Kobra) entered service in 1981 and is a two-part gun-launched weapon which is initially fired out of a gun/missile launcher tube by a booster cartridge at 125 m/s to a point where the single stage short burn solid fuel sustainer rocket motor of the missile cuts in to accelerate to its maximum flight speed of 500 m/s. All the gunner has to do is track the target with his optical sight and the system's fire control computer determines the error in the position of the missile relative to the line-of-sight, converts the data into a course correction signal and transmits it to the weapon via a directional UHF radio command transmitter. The Songster has a secondary capability in the ground-to-air role against low-flying battlefield helicopters. Standard combat load is six AT-8. The complete radio command-guided missile system has the industrial index number 9K112.

SPECIFICATIONS (provisional)

radio command SACLOS LENGTH 1.2 m DIAMETER 0.125 m WING SPAN 0.375 m LAUNCH WEIGHT 25 kg 6-7 kg HEAT WARHEAD 500-4000 m RANGE ARMOUR PENETRATION 800 mm SPEED 500 m/s

Status: In production. In service with the former Soviet Army.

Armoured Vehicle Applications

T-64B, T-64B1, T-64BV, T-64B1V MBT (125 mm gun/missile launcher -CIS Armies)

T-80, T-80B, T-80BV MBT (125 mm gun/missile launcher - CIS Armies).

Manufacturer: State factories.



T-64B MBT fitted with explosive reactive armour firing AT-8 Songster ATGW

AT-6 Spiral

Development/Description

The radio command-guided tube-launched AT-6 Spiral (industrial index number 9M114, named Shturm-S, Assault ground and Shturm-V, Assault airborne) Semi-Automatic Command to Line-Of-Sight (SACLOS) anti-tank missile first entered service in 1973 as a helicopter-launched anti-tank weapon (the Shturm-V) for the Mil Mi-24 Hind. It has subsequently been fitted to other helicopters such as the Mil Mi-28 Havoc and Kamov Ka-29 Helix-B.

In 1990 it was revealed that a multi-role vehicle (industrial index number 9P149) based upon a modified MT-LB tracked vehicle had been in service since 1983. This used a single rail automatically reloaded launcher assembly to engage both ground and armoured vehicle targets and low speed airborne targets such as helicopters.

All the gunner has to do is keep his day/night sight cross-hairs on the target until the missile impacts. Airborne targets with crossing/approach speeds of 60 m/s and altitudes from ground level up to 3000 m can be engaged. The system is generally immune to countermeasures, since the missile's IR beacon tracking signal is pulsed and the radio guidance signal encoded. In addition to the hollow charge warhead, there is also an HE-fragmentation warhead which is particularly effective against helicopters. Both warheads have contact fuzes. Rate of fire of the system aboard the 9P149 is 3-4 rds/min with a total of 12 missile launcher-containers carried.

SPECIF	ICAT	IONS
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 TYPE
 radio command SACLOS

 LENGTH
 1.83 m

 DIAMETER
 0.13 m

WING SPAN 0.25 m

 LAUNCH WEIGHT

 with container-launcher tube
 46.5 kg

 missile
 40 kg

 WARHEAD
 7-8 kg HEAT

 RANGE
 250-5000 m

RANGE 250-5000 m ARMOUR PENETRATION 600-700 mm SPEED

at launch 55 m/s in flight 350-400 m/s

Status: In production. In service with Afghanistan, Bulgaria, the former Czechoslovakia, Hungary, Iraq, Poland, Syria and the CIS.

Armoured Vehicle Applications

Tracked 9P149 (MT-LB variant single-tube rail launcher - CIS Armies)

Manufacturer: State factories.



MT-LB tracked vehicle with AT-6 Spiral launcher in elevated position





AT-6 Spiral ATGW out of launcher tube (top) and in launcher tube (lower)

AT-5 Spandrel

Development/Description

The NATO designated AT-5 Spandrel (industrial index number 9M113, named Konkurs - meaning contest) entered operational service in 1974-75 and is a second generation heavyweight wire-guided tube-launched Semi-Automatic Command to Line-Of-Sight (SACLOS) vehicle- or ground-mounted ATGW, which is similar in appearance and performance to the Euromissile HOT. All the gunner has to do is keep his day/night sight cross-hairs on the target until the missile impacts.

The launch unit for ground use is the same as that used for the later versions of the AT-4 Spigot and identical interfaces allow the two missiles to be fired from the other system. Combat load for the 9P148 launcher vehicle is 15 Spandrel or 20 Spigot; mixes can also be accommodated. An AT-4/5 ground mount is carried for dismounted use.

SPECIFICATIONS

TYPE wire-guided SACLOS

LENGTH 1.22 m

DIAMETER 0.135 m

WING SPAN 0.45 m

LAUNCH WEIGHT 22 kg

WARHEAD 3 kg hollow charge

RANGE 75-4000 m

 RANGE
 75-4000 m

 ARMOUR PENETRATION
 650 mm

 SPEED
 250 m/s

Note: More recently a version with a tandem warhead has entered production

Status: In production. In service with Afghanistan, Algeria, Bulgaria, CIS, Czech Republic, Hungary, India, Iraq, Poland, Slovakia and Syria.



Former Czechoslovakian BMP-2 with AT-5 Spandrel over 30 mm cannon



Close-up of AT-5 Spandrel ATGWs on BRDM-2 (4 × 4) chassis

Armoured Vehicle Applications

Tracked BMP-2 (single-tube turret launcher - Afghanistani, Algerian, CIS, Czech, Indian, Iraqi, Polish, Slovakian and Syrian Armies)

Tracked BMD-1M (single-tube turret launcher - former Soviet Army Airborne units)

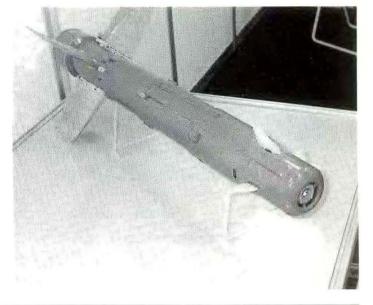
Tracked BMP-30 (single-tube turret launcher - Bulgarian Army) Tracked BMP-23A (single-tube turret launcher - Bulgarian Army)

Tracked BMP-23 (single-tube turret launcher - Bulgarian Army)

 4×4 9P148 (BRDM-2 derivative with five-tube launcher system - CIS Armies, Czech, Hungarian, Iraqi, Polish, Slovakian and Syrian Armies. Former Soviet Naval Infantry).

4 × 4 Fahd 30 AFV (single-tube launcher).

Manufacturer: State factories.



AT-5 Spandrel ATGW out of its launcher (Christopher F Foss)

AT-4 Spigot

Development/Description

The NATO designated AT-4 Spigot (industrial index number 9M111, name Fagot: Bassoon) entered operational service in 1973 and is a wire-guided second generation medium-range Semi-Automatic Command to Line-Of-Sight (SACLOS) tube-launched ATGW for use from ground or vehicle mounts. All the gunner has to do is keep the cross-hairs of his sight on the target until the weapon impacts. The AT-4 has seen combat service with the Angolan Army against South Africa and UNITA, the Yugoslavian internal conflict, the Libyans in Chad, the Polisario Front against Morocco, the Syrian Army during the 1982 Lebanon War, the Iraqi Army during the Iran-Iraq Gulf War and the 1991 Gulf War and the former Soviet Army in Afghanistan. Examples have been captured by Israel, South Africa, the Gulf Coalition Forces and the Mojahedin guerillas.

The ground mount has a maximum elevation of about +35° thus allowing targets at altitudes of between 1100-1200 m above the launcher at maximum missile range to be engaged. These targets can include hovering or very slow moving helicopters. The ground mount of the latter Spigot versions can also take the AT-5 Spandrel launch tube.

Two versions of Spigot are available: Spigot-A (the 9M111) and Spigot-B (9M111-2). The dimensions and weight of both missiles are identical, as are their aerodynamic shapes. However, because of improvements to the sustainer motor and lengthened guidance wire, Spigot-B has an increased range. It also has an improved warhead to increase armour penetration.

SPECIFICATIONS (provisional)

wire-guided SACLOS

LENGTH 0.838 m DIAMETER 0.120 m WING SPAN 0.36 m

LAUNCH WEIGHT 6 kg WARHEAD 2.5 kg hollow charge RANGE Spigot-A 70-2000 m Spigot-B 70-2500 m ARMOUR PENETRATION Spigot-A 400 mm

Spigot-B 460 mm

185 m/s

Note: More recently a version with a tandem warhead has entered production

Status: In production. In service with Afghanistan, Algeria, Angola, Bulgaria, CIS, Cuba, Czech Republic, Ethiopia, Finland, Hungary, India, Iraq, Kuwait, Mozambique, Poland, Polisario Front, Slovakia, Syria, and Yugoslavia

Armoured Vehicle Applications

Tracked BMD-1M (single-tube turret launcher - CIS Airborne units) Tracked BMP-1M (single-tube turret launcher - Cuban, Czech, Finnish, Indian, Iraqi, Polish and Slovakian Armies)

Tracked BMP-2 (single-tube turret launcher - Afghanistan, Algerian, CIS, Czech, Indian, Iraqi, Kuwait, Polish and Slovakian Armies)

 4×4 9P148 (BRDM-2 derivative with centre three positions of five-round system - CIS, Czech, Hungarian, Iraqi, Polish and Slovakian Armies) 6 × 6 SISU XA-180 (single-tube launcher - Finnish Army).

Manufacturer: State factories



Standard infantry version of AT-4 Spigot

AT-3 Sagger

Development/Description

The NATO designated AT-3A Sagger-A (industrial index number 9M14, name Malyutka) entered service in 1961 as the third first-generation ATGW to be fielded within four years from 1957 when the NATO designated AT-1 Snapper (industrial index number 3M6, name Shmel: Bumblebee) radioguided weapon appeared on BRDM-1 and GAZ-66 launcher vehicles. The Sagger-A used wire-guided Manual Command to Line-Of-Sight guidance (MCLOS) and was fired from both vehicle and ground rail mounts.

In the mid-sixties the improved NATO-designated AT-3B Sagger-B entered service and this was followed in 1969 by a second-generation variant, the AT-3C Sagger-C (industrial index number 9M14M, name Malyutka-M). This uses a Semi-Automatic Command to Line-Of-Sight (SACLOS) guidance

system. Both the Sagger-B and Sagger-C are used from helicopter and vehicle mounts. Only the Sagger-A and Sagger-B are used from ground

Yugoslavia manufactures the Sagger under licence for both air- and ground-launched applications. A more recent Yugoslav model, with a stand-off probe, is called the 9M14MP1

The Sagger family has seen extensive combat use from the 1968-70 Arab-Israeli War of Attrition to the present day in such conflicts as Angola, Chad, the 1973 Yom Kippur War, Cambodia, Lebanon, Sri Lanka, the 1979 Sino-Vietnamese border war, the Thai-Laotian border skirmishes, the Thai-Cambodian border skirmishes, Uganda, Vietnam, the Iran-Iraq Gulf War, the 1991 Gulf War, the Yugoslavian internal conflicts and the various internal conflicts within the former Soviet Republics.

Large numbers have been captured by countries such as Chad, China, France, Iran, Israel, South Africa, and the United States. From these,

VEHICLE-MOUNTED ANTI-TANK GUIDED WEAPONS / CIS

unlicensed copies have been produced by China (as the Red Arrow 73 and the improved Red Arrow 73C with second generation SACLOS guidance), Iran, North Korea and Taiwan (as the Kuen Wu 1 with a more rounded warhead section).

SPECIFICATIONS

TYPE

LENGTH

DIAMETER

ARMOUR PENETRATION

SPEED

WING SPAN

LAUNCH WEIGHT WARHEAD

SACLOS

AT-3C wire-guided SACLOS

Red Arrow 73 0.86 m Kuen Wu 1 0.88 m

0.119 m 0.37 m

Red Arrow 73 2.5 kg HEAT

AT-3A/B/C 410 mm Red Arrow 73 500 mm Kuen Wu 1 450 mm Sagger-A 120 m/s

AT-3A/B wire-guided MCLOS Red Arrow 73 wire-guided MCLOS Red Arrow 73C wire-guided Kuen Wu 1 wire-guided MCLOS AT-3A/B/C 0.86 m AT-3A/B/C 2.5 kg HEAT Kuen Wu-1 2.75 kg HEAT

Sagger-B/C 150 m/s



WZ 501 of Chinese Army with Red Arrow 73 ATGW over 73 mm gun



Yugoslav BVP M80A with twin Saggers to rear of turret (Christopher F Foss)



Basic infantry version of AT-3 Sagger with gunner in background

Status: AT-3: production complete. In service with Afghanistan, Algeria, Amal Militia, Angola, Bulgaria, Cambodia, Congo, CIS, Cuba, Czech Republic, Egypt, Ethiopia, Finland, Guinea, Guinea-Bissau, Hungary, India, Iran (and unlicensed copy), Iraq, Israel, North Korea (and copy), Laos, Libya, Mali, Mongolia, Mozambique, PLO, Poland, Romania, Slovakia, Syria, Uganda, Vietnam, Yugoslavia and Zambia.

Red Arrow 73: In production. In service with China, Iran, North Korea, Tanzania and several unidentified countries.

Kuen Wu 1: In production. In service with Taiwan.

Armoured Vehicle Applications

Tracked M1985 light tank (single-rail launcher - North Korean Army) Tracked AIFV (unknown Kuen Wu 1 launcher system - Taiwanese Army) Tracked BMD/BMD-1 (single-rail Sagger-A/C turret launcher - former Soviet Army airborne units)

Tracked BMP/BMP-1 (single-rail Sagger-A/C turret launcher - all BMP/BMP-1 users)

Tracked Type 504 (twin-retractable rail launcher - Chinese Army)

Tracked WZ 501 (single-rail Red Arrow 73 turret launcher - Chinese Army) Tracked YW 309 (single-rail Red Arrow 73 turret launcher - Chinese Army) Tracked BVP M80A LT (two three-rail launchers - 50 plus with former Yugoslavian Army)

Tracked BVP M80A and M80AK (twin-rail turret launcher - 600 plus with former Yugoslavian Army)

Tracked M-80 MICV (twin-rail turret launcher - 500 plus with former Yugoslavian Army)

8 x 8 TAB-77 (two-rail turret launcher - 900 plus with Romanian Army) 8 × 8 OT-64 SKOT-2A (two-rail turret launcher - 600 plus with Polish Army) 4 x 4 9P110 (BRDM-1 derivative with two three-rail Sagger-A/B launchers known users Romanian (50 plus) and former Soviet (400 plus) Armies) 4 x 4 9P122 (Sagger-A/B) and 9P133 (Sagger-C) (BRDM-2 derivatives with two three-rail launchers - known users are the armies of Afghanistan (30 plus), Algeria (50 plus), Bulgaria (100), CIS (3000 plus), Czech, Egypt (100 plus), Ethiopia (40 plus), Hungary (50 plus), Iran (50 plus), Iraq (200 plus), Libya (100 plus), Mongolia (30 plus), Poland (100 plus), Romania

(150), Slovakia, Syria (150 plus) and Yugoslavia (80 plus) together with 100 plus of the CIS Naval Infantry) 4×4 BOV-1 (two three-rail launchers - 40 plus with Yugoslavian Army).

Manufacturer: Chinese, CIS, Iranian, North Korean, Taiwanese, and Yugoslav state factories.

AT-2 Swatter

Development/Description

The NATO designated AT-2A Swatter-A (name Falanga) first entered service in 1960 and was the second first-generation radio-guided manual command to line-of-sight vehicle-mounted ATGW to be fielded by them. The Swatter-A was superseded in 1965 by the improved NATO designated AT-2B Swatter-B (name Fleyta) which had a longer range and improved ECCM capabilities. Its use was relatively short-lived but was extended to include firings from helicopter mounts. The final version, NATO designation AT-2C Swatter-C (name Skorpian), entered service around 1969 to supplant the other two on vehicle and helicopter mounts. This uses a second generation Semi-Automatic Command to Line-Of-Sight (SACLOS) radio guidance system with terminal IR homing. Limited combat use of the AT-2C is believed to have occurred with former Soviet forces in Afghanistan.

SPECIFICATIONS (provisional)

TYPE

LENGTH DIAMETER WING SPAN LAUNCH WEIGHTS

WARHEAD RANGES

ARMOUR PENETRATION

SPEED

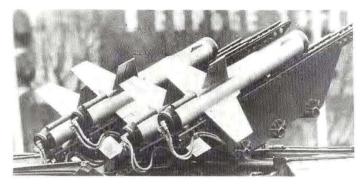
AT-2A/B radio-guided MCLOS AT-2C infra-red/radio command

SACLOS 1.16 m 0.148 m 0.7 m AT-2A 27 kg AT-2B/C 29 kg 5.4 kg HEAT AT-2A 500-3000 m AT-2B 500-3500 m AT-2C 250-4000 m

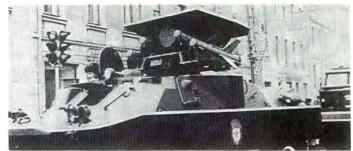
AT-2A 480 mm AT-2B/C 510 mm

150 m/s

Status: Production complete. In service with Bulgaria, CIS, Czech, Egypt, Hungary, Iraq, Libya, Poland, Romania, Slovakia, Syria, Vietnam and Yemen



Close-up of four-round Swatter launcher on BRDM-1



Close-up of BRDM-2 with Swatter-C ATGW

Armoured Vehicle Applications

4 × 4 BRDM-1 (two twin Swatter-A/B rail launchers - some CIS units) 4 × 4 BRDM-2 (two twin Swatter-C rail launchers - CIS units).

Manufacturer: State factories.

INTERNATIONAL

Euromissile HOT

Development/Description

The Euromissile HOT system (Haut subsonique Optiquement teleguide tire d'un Tube) was jointly developed by Aerospatiale and Messerschmidt-Bölkow-Blohm from 1964 onwards and entered operational service in 1977. It is a heavyweight spin-stabilised wire-guided tube-launched ATGW with a 150 mm calibre warhead (HOT-2) for use from ground, vehicle or helicopter mounts. The guidance used is of the Semi-Automatic Command to Line-Of-Sight (SACLOS) type with an infra-red tracking system. All the gunner has to do is to keep his optical sight cross-hairs on the target to ensure a hit.

In 1993 the improved HOT-2T version entered service with a warhead optimised for use against the new generation armour.

A multipurpose warhead is also available. This can penetrate up to 500 mm of armour and produce a fragmentation pattern of over 1000 steel spheres following detonation because of the use of the steel spheres around the edges of the hollow charge. The HOT-2 MP also has an incendiary effect because of a chemical compound around the front of the hollow charge. The 5-6 mm pre-formed splinters are effective out to a distance of 20-30 m from the detonation point.

In 1993 the HOT-3 variant will be available. This has a tandem HE charge system for use against reactive armour packages.

HOT has seen combat service with the French Army in Chad, the Cameroon Air Force during the 1984 coup attempt in that country, the Syrian Air Force in Lebanon during the 1982 Peace for Galilee War, the Moroccan Air Force in the Sahara conflict, with the Iraqi Army and Air Force in its war with Iran and the 1991 Gulf War (by Kuwait, Iraq, France, Qatar, Saudi Arabia and the United Arab Emirates).

By January 1993 78 000 missiles had been ordered together with 762 vehicle and 716 helicopter launcher systems by 17 countries.

An upgrade available but not yet implemented for HOT launcher systems is the replacement of the present analogue guidance electronics by digital circuitry. This reduces the overall system weight and improves the reliability

In 1992 the vehicle-mounted Mephisto and the helicopter-mounted Viviane launcher systems were improved by the adoption of an infra-red tracker unit operating at the 0.9 µm wavelength band to increase resistance against optical countermeasures. Together with the thermal imager, the localisation unit will operate in a bispectral mode.

SPECIFICATIONS

SPEED

TYPE wire-guided SACLOS LENGTH 1.275 m DIAMETER 0.15 m WING SPAN 0.33 m LAUNCH WEIGHT HOT-2 32 kg HOT-3 32.5 kg

WARHEAD HOT 2 6 kg (4.1 kg HE) HEAT HOT-3 6.5 kg (4.1 kg HE) HEAT

RANGE 75-4000 m ARMOUR PENETRATION HOT-2 1250 mm

HOT-2MP 500 mm + behind armour effect

HOT-3 1250 mm (including one

layer reactive armour)

235 m/s

Status: In production. In service with Cameroon, China, Cyprus, Ecuador, Egypt, France, Gabon, Germany, Iraq, Kuwait, Lebanon, Morocco, Qatar. Saudi Arabia, Spain, Syria and the United Arab Emirates.

Armoured Vehicle Applications

Tracked AMX-10P (four-tube Lancelot 1 turret - Saudi Arabian Army) Tracked Jaguar 1 (single-tube automatic recharge launcher - 316 with German Army)

8 x 8 MOWAG Piranha (four-tube Lancelot 3 turret - 98 with Saudi Arabian Army)

6 × 6 Panhard VCR/TH (four-tube UTM 800 turret - 100 with Iraqi Army) (many of these were lost during the 1991 Gulf Conflict)

6 × 6 VAB-VCAC (four-tube UTM 800 turret - 24 with Qatari Army and 18 delivered to Cyprus)

4 x 4 VAB-VCAC (four-tube Mephisto turret - 135 delivered to French Army)



VAB (4 × 4) with four-round Mephisto launcher in raised position (C R Zwart)



VAB (6 × 6) with UTM-800 turret with four HOT ATGWs (Christopher F Foss)

Armoured Vehicle Trial Applications

Tracked AMX-13 (two three-tube launchers either side of turret)

Tracked Warrior MCV (four-tube HCT turret)

Tracked Cazador M41E (four-tube HCT turret)

Tracked LOHR VPX 5000 (four-tube HCT turret)

Tracked Wiesel airportable vehicle (two-tube HCT turret)

Tracked Spartan (four-tube HCT turret)

Tracked Stormer (four-tube HCT turret)

Tracked Jaguar 1 (four-tube HCT turret)

8 × 8 MOWAG Piranha (four-tube Mephisto turret)

6 x 6 BMR-600 (four-tube HCT turret)

6 x 6 Daimler - Puch Pandur (four-tube UTM 800 turret)

4 × 4 Simba LCV (four-tube HCT turret)

4 × 4 Panhard VCR/TH (four-tube Mephisto turret)

4 × 4 Condor (four-tube HCT turret)

4 × 4 RPX-6000 (four-tube HCT turret).

Note: Details of the Mephisto launcher and UTM 800 turret are given in the Turrets and Cupolas section later in this book.

Manufacturer: Enquiries to Euromissile, 12 rue de la Redoute, E-92260

Fontenay-aux-Roses, France. Telephone: (1) 46 61 73 11 Telex: EUROM 204691 F

Euromissile MILAN

Development/Description

The Euromissile MILAN (Missile d'Infanterie Leger Antichar) is a second generation tube-launched spin-stabilised ATGW which is capable of being launched from either ground or vehicle mounts. The weapon is fitted with a 103 mm calibre HEAT warhead and Semi-Automatic Command to Line-Of-Sight (SACLOS) guidance that uses 2 µm wavelength infra-red tracking system. All the gunner has to do to ensure a hit is to keep the cross-hairs of his optical or thermal imaging sight on the target.

In 1984 the MILAN 2 version entered service with the French. German and British Armies. This uses an improved 115 mm calibre HEAT warhead with a 280 mm long stand-off nose-probe to optimise its anti-armour capabilities against the new armour. For night use there is the 8.5 kg MIRA 8-13 µm wavelength thermal imaging sight with a 4000 m detection range. This is also used by France, Germany and the UK.

In 1993 the MILAN 2T variant will be available. This uses the improved 115 mm calibre warhead of MILAN 2 with a 30 mm diameter HE precursor charge mounted in an extendable nose-probe that extends upon launch. The warhead is designed specifically to defeat ERA type armour.

MILAN has seen combat service in the 1982 Falklands War with the British Army, in Chad with the French and Chadian Armies, in the various conflicts in Lebanon with the French, Lebanese and Syrian Armies, in the Saharan conflict with the Moroccan Army, in the 1987-88 Angolan battles with South Africa, in Afghanistan with the Mojahedin, the armies of both sides in the Iran-Iraq War and in the 1991 Gulf War.

MILAN has a limited anti-helicopter capability against hovering, low-level head-on and slowly crossing targets. A maximum height of 380 m is reached at 1800 m range.

To take the system off a vehicle for ground post use takes only about 20 seconds

By late 1992 over 9840 Milan firing posts and more than 332 000 missiles had been ordered by 38 countries.

The Milan 3 weapon system is due to complete its development programme in 1993 with service entry in the French army scheduled for 1994. The Milan 3 comprises a firing post equipped with a new generation localiser to reduce immunity to jamming systems. The MIRA thermal sight remains fully compatible to provide both a day- and night-time firing capability. The Milan 3 round is equipped with the tandem warhead and a lamp flashing unit to aid in guidance.

The tracking system relies on a Charged Coupled Device (CCD) taking two pictures of the landscape on a sequential basis. The first is timed before the missile lamp flashes and the second at the instant of the lamp flash. The lamp flash synchronisation is undertaken before the weapon is fired. The two 'pictures' are memorised and processed in a microcomputer which subtracts one image from the other. Only the missile lamp flash remains in the memory as all other IR sources are suppressed, thus guidance commands can be created from the missile movements and not any decoys, for example,



MILAN 2 with MIRA night sight

SPECIFICATIONS

SPEED

wire-guided SACLOS LENGTH MILAN 1 0.769 m MILAN 2 0.918 m MILAN 2T 1.138 m (extended

0.125 m (wings folded) DIAMETER WING SPAN 0.265 m

LAUNCH WEIGHT MILAN 1/2 6.7 kg MILAN 2T 7.1 kg MILAN 1 2.7 kg (1.3 kg HE) HEAT WARHEAD

MILAN 2 2.7 kg (1.8 kg HE) HEAT MILAN 2T 3.1 kg (1.83 kg HE) 25-2000 m (MILAN 2T 25-1920 m) RANGE

ARMOUR PENETRATION MILAN 1 600 mm MILAN 2 880 mm

MILAN 2T 880 mm (including a

layer of ERA) 210 m/s

Status: MILAN 1 production complete. MILAN 2 in production. In service with Abu Dhabi, Australia, Belgium, Botswana, Burundi, Cameroon, Chad, Chile, Cyprus, Egypt, France, Gabon, Germany, Greece, India (licensebuilt by Bharat Dynamics), Indonesia, Iraq, Ireland, Italy (licenced produced), Kenya, Lebanon, Mauritania, Mexico, Morocco, Oman, Pakistan, Portugal, Qatar, Rwanda, Senegal, Singapore, Somalia, South Africa, Spain, Syria, Tunisia, Turkey, Uruguay, the UK (was license-built by BAe Dynamics) and the USA (trials batch) together with one unidentified country.

Armoured Vehicle Applications

Tracked AMX-VCI (single-tube launcher - Belgian Army) Tracked M113-B-MIL (single-tube launcher - Belgian Army) Tracked AMX-10P (one or two single-tube launchers - French Army) Tracked Spartan (two-tube MCT turret - 75 with British Army) Tracked Marder 1 ICV (single-tube launcher - most of the 670 Marder A1 and 1466 Marder 1A1 deployed with German Army) 4 × 4 VAB (single-tube launcher - French Army)

4 x 4 Panhard VBL (single-tube launcher - French and Mexican (8) Armies)

4 × 4 EE-3 Jararaca (single-tube launcher - Cypriot Army).

Armoured Vehicle Trial Applications

Tracked LOHR RPX 5000 (two-tube MCT turret) Tracked LOHR RPX 5000 (single-tube launcher) 6 x 6 Transportpanzer 1 (two-tube MCT turret)

6 × 6 VAB (two-tube MCT turret)

4 × 4 BDX (two-tube MCT turret)

4 x 4 Panhard M3 (two-tube MCT turret)

4 x 4 Panhard VCR (two-tube MCT turret)

4 × 4 VAB (two-tube MCT turret)

4 × 4 LOHR RPX 6000 (two-tube MCT turret)

4 × 4 LOHR RPX 3000 (single-tube launcher)

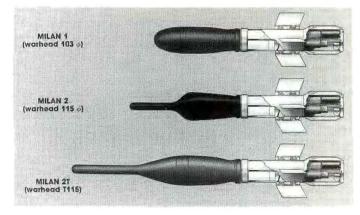
4 × 4 RAMTA V-1 (single-tube launcher) 4×4 TM-170 (twin-tube MCT turret).



Alvis Spartan of British Army with MCT (MILAN Compact Turret) (Christopher F Foss)

Redoute, F-92260 Fontenay-aux-Roses, France.
Telephone: (33) 1 46 61 72 28 Telex: EUROM 204691 F

Fax: (33) 1 46 61 24 45



Furomissile MII AN evolution from MII AN 1 to MII AN 2T

EMDG TRIGAT Programme

Development/Description

In 1979 Aerospatiale, British Aerospace and MBB formed the GIE Euromissile Dynamics Group (EMDG Consortium) to develop a number of missile families of varying types.

In 1988 the French, British and German Governments authorised development of a third generation of European long- and medium-range anti-tank missiles to replace the MILAN, HOT and Swingfire systems. These weapons are the TRIGAT Medium- and Long-Range Anti-tank Systems, designs selected from studies carried out in 1986. Other NATO nations are interested in participating in the projects: Belgium and the Netherlands are involved in the Medium-Range project.

TRIGAT Medium-range Missile

The 1.2 m long Trigat MR is expected to enter operational service at the end of 1997 and uses thrust control and low ejection velocity technology developed by Aerospatiale for its Eryx infantry anti-tank missile. Flight time is 11 seconds to the maximum engagement range of 2000 m whilst minimum range is 50 m.

A tandem HE hollow charge warhead system with an infra-red stand-off fuze is fitted to enable the weapon to defeat all types of current modern armour technology. The missile itself is carried in a sealed canister which acts as the container-launcher tube, the weight of which with the missile is less than 17 kg. The manportable tripod firing post and sight assembly weighs another 16 kg.

Guidance is by Optical Beam Riding (OBR) of a coded Infra-Red (IR) laser beam generated in the 10 µm wavelength region. All the gunner has to do is keep the cross-hairs of his sight on the target. The missile automatically locks-on to the centre beam after launch and receives its flight commands via the laser receiver unit mounted at its rear. An optical day sight is supplemented by an optional clip-on thermal imaging night sight to give the system an all-weather day or night engagement capability in fog, haze or battlefield smoke conditions.

Maximum rate of fire is 3 rds/min in the manportable role. Significantly, MR has the capability of being fired from enclosed spaces. The weapon also has the capability of engaging low flying or hovering helicopters.

For use on armoured vehicles an adapted pintle-type mounting is being developed. A more sophisticated integrated compact turret installation has also been studied. In each case the basic launcher tube, sight and guidance equipment used is the same

TRIGAT Long-range Missile

The larger 1.57 m long, 0.155 m body diameter TRIGAT LR is of the all weather day and night fire-and-forget type for launch either from helicopter or vehicle mounts. Initial operational capability is due for 1997.

Guidance is by an automatic passive infra-red CCD homing seeker. Each image recorded is compared to the preceding one by the onboard guidance microprocessor system. This generates flight commands which are transmitted to the aerodynamic flight control surfaces.

A tandem HE hollow charge warhead system is fitted with the missile adopting either a terminal dive to attack armoured targets or a direct attack profile to engage low flying or hovering helicopters.

The fire control equipment (computer, display processor, target trackers and alignment processor) evaluates each target acquired by the sensor sight head assembly. This is used for target surveillance, recognition and identification. All the gunner has to do is designate an acquired target for attack. The tracker units allow independent tracking of up to four independent targets, automatically.

Once a target is designated an automatic hand-over sequence is initiated to a missile seeker so that it can lock-on. When this is achieved the missile is fired with the gunner having the option to fire up to four ready-to-fire rounds at individual targets as a salvo.

Missile launch weight is approximately 40 kg with the dual thrust solid propellant rocket motor unit providing range engagement limits of 500 to around 4500 to 5000 m.

The system is designed to be installed on helicopters and is also suitable for a wide range of ground vehicles from MBTs to LAVs.

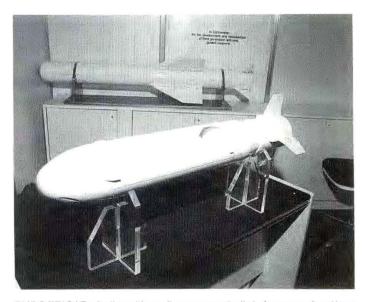
Possible ATGW Armour Installations

Tracked AFV (4-round extendable 15 m turret installation) Tracked AMX-10P (4-round compact turret installation French Army) 4 × 4 or 6 × 6 VAB (4-round compact turret installation French Army).

Status: Advanced development.

Manufacturer: Enquiries to: Euromissile Dynamics Group, 28 rue de la Redoute, F-92260 Fontenay-aux-Roses, France

Telephone: (33) 1 46 61 72 28 Fax: (33) 1 46 61 24 45



EMDG TRIGAT missiles with medium-range missile in foreground and longrange missile in the background

ISRAEL

TAAS - Israel Industries MAPATS

Development/Description

The TAAS - Israel Industries MAPATS ATGW was revealed in 1984 and is an Infra-Red (IR) region modulated laser-generated beam-guided weapon which is tube-launched from ground, vehicle or helicopter mounts. It is similar in appearance to the Hughes I-TOW/TOW 2 series with an extendable nose-probe that operates immediately after launch. All the gunner has to do is keep the cross-hairs of his sight aligned on the target until the missile impacts. Once launched the missile senses the IR-beam via a rear-mounted sensor and measures its deviation from the beam centre. Its digital autopilot uses these data to correct its flight so that it remains aligned to the lineof-sight of the gunner's aiming system.

Night vision aiming capability exists and, with the launcher's elevation capacity to +30° MAPATS, can be used in the anti-helicopter role against hovering or very slow moving targets.

SPECIFICATIONS

 TYPE
 IR beam-guided SACLOS

 LENGTH
 1.45 m

 DIAMETER
 0.148 m

 DIAME I EH
 0.148 m

 WING SPAN
 0.45 m

 LAUNCH WEIGHT
 18.5 kg

 WARHEAD
 3.6 kg HEAT

 RANGE
 65-5000 m

 ARMOUR

PENETRATION 800 mm

SPEED 263 m/s (1000 m range) 216 m/s (2000 m range) 179 m/s (3000 m range) 148 m/s (4000 m range)

118 m/s (5000 m range)

Status: In production. In service with Israel.

Armoured Vehicle Applications

Tracked M113A1 (single-tube launcher) 4 × 4 RBY Mk1 (single-tube launcher).

Manufacturer: TAAS - Israel Industries Ltd, PO Box 1044, Ramat Hasharon

L-47100, Israel.

Telephone: (3) 54 85 222 Telex: 33 719 Fax: (3) 54 06 908



TAAS - Israel Industries MAPATS ATGW mounted on an M151 (4×4) light vehicle

Israel Aircraft Industries Nimrod

Development/Description

IAI MBT Weapon Systems Division is producing the solid propellant fuelled day/night capable Nimrod long-range ground-launched semi-active laser guided ATGW in response to an export requirement. Israeli Defence Force interest has also been expressed. Nimrod can also be used as an anti-ship weapon.

It is transonic in operation and is powered all the way to the target. The gunner pre-selects the flight trajectory mode. This can be direct trajectory, high cruising trajectory or low cruising trajectory, the cruising altitude being constant and between 300 and 1500 m. Mid-course guidance is provided by an integral inertial platform, and terminal guidance by a semi-active laser homing seeker for the last 15-30 seconds of missile flight. The target can be illuminated either by a ground- or airborne-based laser designator.

The gimballed and stabilised seeker head acquires, tracks and homes in on its target using localised proportional navigation. It is said to have a lookangle of more than 30°. In the terminal flight phase the weapon adopts a dive angle of approximately 45° to impact the armoured target on its vulnerable upper surfaces.

The missile is stored in a sealed canister which also acts as the launcher. Total weight of the missile and canister is 150 kg. It has five main sections: seeker, guidance and control, warhead, solid propellant rocket motor and servo. It is roll stabilised in flight. Time to come into action at a launch site is less than three minutes without the site having to be surveyed for alignment or levelling, or with a direct line-of-sight to the target. The weapon can be fixed in single round, ripple or salvo modes.

SPECIFICATIONS

TYPE semi-active laser homing with

inertial mid-course

 LENGTH
 2.6 m

 DIAMETER
 0.17 m

 WING SPAN
 0.4 m

 LAUNCH WEIGHT
 98 kg

WARHEAD 15 kg HE hollow charge

 RANGE
 800-26 000 m

 ARMOUR PENETRATION
 800 mm

 SPEED
 300 m/s

Armour Vehicle Trial Application

Modified AMX-13 light tank chassis (two eight-round container-launcher installations).

Status: Production. On order for unidentified export customer.







Sequence of photographs showing Nimrod engaging a target tank

Manufacturer: Israel Aircraft Industries, MBT Weapons System Division, 70100 Ben Gurion International Airport, Israel.

Telephone: (3) 971 31 11/971 85 12/971 85 14 Cable: ISRAELAVIA Telex: 371 114/371 102/371 133 Fax: (3) 971 31 31/971 22 90

SOUTH AFRICA

Kentron ZT-3 Swift

Development/Description

The ZT-3 was first revealed in 1990 and is a laser beam command-guided Semi-Automatic Command to Line-Of-Sight (SACLOS) weapon which is tube-launched from a helicopter, ground or vehicle-mounted launcher assembly.

All the gunner has to do is keep the cross-hairs of his sight aligned on the target until the missile impacts. Once launched the missile is tracked by use of a pulsed infra-red source and a laser is used to send encoded pulsed guidance commands. The latter's beam is sensed via a rear-mounted sensor which then uses a goniometer to measure the deviation from the beam centre. Its autopilot system uses these data to correct its flight profile so that its actual flight path remains aligned to the line-of-sight of the gunner's aiming system.

Several pre-production ZT-3 Ratel systems were successfully used in combat during the September 1987 Lomba River battles of Operation Modular and the June 1988 Calueque battle destroying at least four T-55 tanks and two BTR-60 APCs. The combination is a new build Ratel Mk III ICV hull fitted with a turret containing a 7.62 mm self-defence MG, missile fire control system and surveillance/target acquisition-tracking optics. A three-round box-shaped launcher is mounted above the turret. Reloading is manual through a troop compartment roof hatch and the system can fire and guide two rounds in less than a minute. A total of 12 reload rounds are carried on racks within the troop compartment. The turret can also be fitted to other suitable vehicles.

SPECIFICATIONS (provisional)

TYPE laser-guided SACLOS LENGTH n/av DIAMETER 0.127 m

WING SPAN n/av LAUNCH WEIGHT n/av

WARHEAD hollow charge with contact fuze RANGE greater than 4000 m

ARMOUR PENETRATION 650 mm plus SPEED 330 m/s

Status: In production. In service with South Africa.

Armoured Vehicle Applications

6 × 6 Ratel ICV (three-round turret launcher - South African Army).

Manufacturer: Prime contractor and system integrator: Kentron.

Enquiries to Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635



Ratel (6 × 6) IFV fitted Kentron ZT-3 Swift ATGW system with three missiles in ready to launch position (Terry Gander)

SWEDEN

Bofors RBS56 Bill

Development/Description

The RBS56 Bill is a tube-launched wire-guided ATGW which is capable of being fired from either ground or vehicle mounts. The weapon is fitted with a canted (at about 30°) hollow charge warhead that produces a downward explosive jet upon activation of a proximity fuze. It flies an Overflight Top Attack (OTA) profile of approximately 1 m above the gunner's line-of-sight.

Guidance is of the Semi-Automatic Command to Line-Of-Sight (SACLOS) type with the firing post utilising an infra-red tracking unit. All the gunner has to do is keep the cross-hairs of either his tripod mounted firing post optical day or clip-on Bill Night Sight (BNS) situated on the target's hull/turret intersection area.

If the missile strikes the target directly then a backup contact fuze detonates the warhead. This also allows the missile to be used in a secondary anti-helicopter role against hovering or slow moving crossing and head-on targets.

SPECIFICATIONS

wire-guided SACLOS TYPE LENGTH 0.9 m

DIAMETER 0.15 m WING SPAN 0.41 m



Bofors RBS56 Bill ATGW system infantry version fitted with Bill Night Sight (BNS)

LAUNCH WEIGHT WARHEAD RANGE ARMOUR PENETRATION SPEED

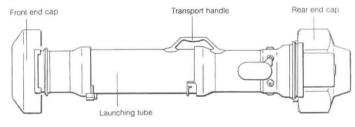
10.9 kg canted HE hollow charge 150-2000 m not available 200 m/s

Status: In production. In service with Austria and Sweden.

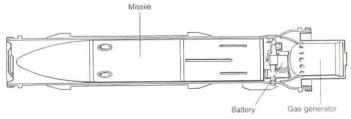
Vehicle Applications

Tracked Pansarbandvagn (Pbv) 302 (single-tube launcher - Swedish Army) Tracked Pansarbandvagn (Pbv) L (single-tube launcher - Swedish Army).

Manufacturer: Bofors AB, S-691 80 Karslskoga, Sweden. Telephone: (46) 586 810 00 Telex: 73210 bofors s Fax: (46) 586 45



Missile container



Missile in launching tube

RBS 56 Bill missile container (top) and launching tube (bottom)

UNITED KINGDOM

British Aerospace Defence Swingfire

Development/Description

The Swingfire entered service with the British Army in 1969 and is the most sophisticated of the first generation optically guided Manual Command to Line-Of-Sight (MCLOS) ATGWs, as it has an autopilot system fitted. The weapon was licence-built in Egypt by the jointly owned Arab British Dynamics company in both the standard and an improved version, known as the Swingfire Mk 4, with a more powerful warhead and propulsion system. By 1991 over 30 000 Swingfire missiles had been built for home and export markets by BAe Dynamics since production started in 1966. In the British Army it may be replaced by the long-range TRIGAT in the late 1990s.

Early in 1989 the British MoD issued a tender to British Aerospace (Dynamics) seeking proposals for the development and production of an improved guidance system for the Swingfire ATGW system. This tender covered the installation of the improved guidance system in a number of Striker vehicles complete with built-in test equipment and second line test equipment. In mid-1990 the MoD awarded a £35 million five year contract to British Aerospace (Dynamics) for implementation of this upgrade programme. The major milestones of the programme have been completed and production commenced in 1993.

The improvement package builds on a 'proof of principle' research programme carried out by the Royal Armament Research and Development Establishment (RARDE) some years ago.

This was designed to demonstrate that representative AFV targets could be tracked and ATGWs accurately guided to intercept them at long range, automatically

In one trial, two Swingfires, fired in quick succession from an FV438 vehicle, were simultaneously and independently guided to hit two separate targets

The combined thermal imaging/optical sight, which entered service with the British Army in 1980, was adopted for the RARDE trials. In its thermal imaging mode it was employed as the sensor for tracking both targets and missiles during an engagement. The video imaging channel was supplied to a specially developed signal processing unit known as the Multiple Target and Missile Tracker (MTMT) produced by BAe. This enables the independent tracking of up to four thermal sources in the combined sight.

Once the missiles are launched, the MTMT automatically acquires the missiles' thermal images as they enter the field of view and automatically tracks the missiles relative to the combined sight boresight.

The MTMT generates the angular displacement between the targets/ missiles. This generates control signals that are sent to each missile to bring its flight path coincident with the target position. Each missile continues along its path until impact.

The missile can be fired over a 10° high concealing feature in front of the launcher. Striker ATGW vehicles were used by the British Army during the 1991 Gulf War.

SPECIFICATIONS

wire-quided MCLOS with autopilot TYPE (upgraded version ACLOS) LENGTH 1.067 m DIAMETER 0 17 m WING SPAN 0.373 m LAUNCH WEIGHT 27.05 kg 7 kg HEAT WARHEAD RANGE 150-4000 m ARMOUR

PENETRATION 800 mm SPEED 185 m/s

Status: Production complete in UK (30 000 plus built). In service with Belgium, Egypt, Iraq, Kenya, Nigeria, Qatar, Saudi Arabia, Sudan, United Arab Emirates and the United Kingdom.

Armoured Vehicle Applications

Tracked FV102 Striker (five-round system, 43 in Belgian Army and 87 in British Army)

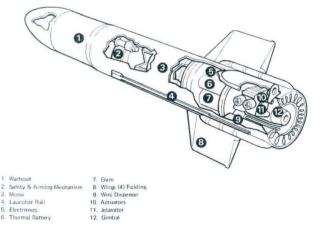
4 × 4 Walid (four-round system, small number Egyptian Army).

Manufacturer: British Aerospace Defence Limited, Dynamics Division, Six Hills Way, Stevenage, Hertfordshire SG1 2DA, United Kingdom.

Telephone: (0438) 312422 Telex: 825125/825126 Fax: (0438) 753377



Striker launching a British Aerospace Defence Swingfire ATGW



Main components of Swingfire ATGW

UNITED STATES OF AMERICA

Rockwell Hellfire Modular Missile System

Development/Description

The AGM-114 Hellfire modular multipurpose missile system is currently inservice in several semi-active laser guided configurations with the US Armed Forces and several other nations.

The fielded missile has a minimum range of 500 metres and a maximum range of 8000 metres. The current guidance system employs a Semi-Active Laser (SAL) seeker and an analogue autopilot. SAL missiles home on laser energy reflected off a target that has been illuminated by a laser designator/laser target marker. The laser can either be on the launch platform or another platform that can be separated from it by several miles.

Hellfire was originally developed as the main weapon for the McDonnell Douglas AH-64 Apache attack helicopter, the SAL guidance being matched to its tactical employment concepts as both it and the OH-58D/AHIP scout helicopter each have Hellfire compatible lasers. The available engagement options are called the autonomous engagement mode and the co-operative engagement mode, depending upon whether the launch platform or the scout marks the target. The term remote lasing is synonymous with the cooperative engagement mode.

The system has also been adapted for ground use. As of early 1993 18 launchers have occurred from HMMWV trucks, five from CUCV trucks and three from modified M113 APCs. In the Summer of 1992 four missiles were fired from a modified Sea Chaparral launcher.

Hellfire uses pulse coded laser illumination at the 1.06 µm wavelength so that the missile will only lock-on to what it is supposed to. As a result, Hellfire can be fired before a lock-on has been achieved, with target acquisition being achieved in flight. Alternatively, it can be inhibited from igniting its motor until after a lock-on has been achieved. The latter situation, called Lock-On-Before-Launch (LOBL), allows maximum positive weapon control as a way to minimise fractricide in close combat. The former condition, Lock-On-After-Launch (LOAL), allows for the use of indirect fire modes, plus it enhances operations in situations of dust, smoke or low

61

overcast. In the indirect fire modes Hellfire can also be employed from behind masking features of up to 304.8 m in height. LOAL also allows delay in turning on the laser, which enhances designator survivability. There are also two ways for simultaneous multiple target engagements to occur, the more common allowing a missile launch every eight seconds.

The Hellfire is currently fielded in the following versions:

- (a) AGM-114A first production model
- (b) AGM-114B US Marine Corps Hellfire with Improved Low Visibility (ILV) autopilot for low visibility conditions; minimum smoke rocket motor; shipboard-qualified Safe and Arm Device (SAD) for rocket motor
- (c) AGM-114C same as AGM-114B except without USMC SAD unit
- (d) AGM-114F same as AGM-114C except fitted with a precursor warhead charge to provide tandem warhead configuration
- (e) Anti-ship Hellfire a model C fitted with an anti-ship penetrating blast-fragmentation warhead plus some slight autopilot modifications to allow higher launch elevations and shallower obliquity against vertical targets used by Sweden as RBS 17.

Hellfire was originally developed by the US Army to destroy MBTs. One of the requirements, though, was to hit manoeuvring targets at up to 20° to the right or left of the launch azimuth at distances of up to 1000 metres of the firing platform. This meant that Hellfire had to be designed with manoeuvrability features normally seen in anti-aircraft weapons rather than anti-tank missiles. At the same time the warhead was required to provide adequate margins of lethality against all forms of evolving armour. The result is a multiple purpose weapon capable of destroying virtually all tactical point targets from manoeuvring helicopters to MBTs to fixed installations. Against naval targets a single Hellfire is considered to be able to sink or disable missile boats up to 40 m in length and one variant is believed to be able to sink a troop ship in the 4000 ton class with only a small number of hits.

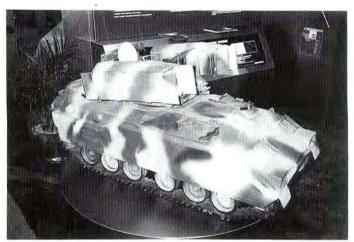
The modularity of Hellfire allows for any improvements to retain effectiveness or exploit emerging technology to be readily incorporated. Two advanced SAL seekers are currently in development which provide resistance to electro-optical countermeasures. One of these is the seeker for the Hellfire Optimised Missile System (HOMS), a new missile also known as Hellfire II. The other seeker is called the Hellfire Enhanced Laser Seeker (HELS), and this is obtained from the current production configuration by replacing a single circuit card with a Rockwell-proprietary digital design. This can either be done in retrofit or as new production.

There are also two millimetre wave radar seekers in development or about to begin development: the Longbow and the Brimstone configurations.

An imaging infra-red seeker is also in development and a laboratory prototype has successfully acquired cold point targets at over 5000 metres range. This seeker incorporates a 256×256 Staring Focal Plane Array (StFPA) using mercury cadmium telluride on a sapphire substrate and sensing in the 4 plus μm region of the Mid-Wavelength Infra-Red (MWIR) band. The current analogue autopilot and rocket motor are both second generation versions of these devices to go into production. Digital autopilots have been developed but as yet not entered the production stage. Insensitive munitions will be developed within the next few years.

In 1973 a Hellfire RF/IR air defence supression variant was demonstrated, with direct hits being achieved in each of the three valid test shots.

First combat use for Hellfire occurred in 1989/90 during Operation Just Cause when seven rounds were fired against Panamanian armoured vehicles, the main Panamanian Defence Force HQ and the main command and control radio broadcasting stations. The main use to-date, however.



Model of Bradley Infantry Fighting Vehicle chassis fitted with turret-mounted Hellfire system called the Ground-Launched Hellfire-Heavy (GLH-H) (Christopher F Foss)

was in the Second Gulf War when some 4000 rounds were fired from AH-64 Apaches, AOH-58D Kiowa Warriors and AH-1W Super Cobra helicopters. The first attack of the war on two Iraqi radar installations involved Apaches using Hellfires. Other targets engaged included oil derricks being used as anti-aircraft missile platforms, moving and stationary vehicles of all types and a medium bridge (which was destroyed by firing missiles into each of the pylons until the whole structure collapsed). The rounds used in both situations were the AGM-114C (US Army) and AGM-114B (US Marine Corps) variants.

SPECIFICATIONS

SPECIFICATIONS	
TYPE	multiple purpose with semi-active lasing homing seeker
LENGTH	
AGM-114A/B/C	1.6 m
AGM-114F	1.8 m
Anti-ship	1.6 m
DIAMETER	0.18 m
WING SPAN	0.33 m
LAUNCH WEIGHT	
AGM-114A/B/C	45.5 kg
AGM-114F	48.6 kg
Anti-ship	47.7 kg
WARHEAD	
AGM114A/B/C	HE unitary shaped charge
AGM-114F	HE tandem shaped charge
Anti-ship	HE-blast fragmentation
RANGE	
AGM-114A/B/C	500-8000 m
AGM-114F	n/av
Anti-ship	n/av
ARMOUR PENETRATION	n/av
SPEED	
AGM-114A/B/C	Mach 1.4
AGM-114F	Mach 1 plus
Anti-ship	Mach 1 plus

Status: Production. In service with Israel, US Army and US Marine Corps. On order for Egypt, Greece, South Korea, Saudi Arabia, Sweden and the United Arab Emirates.

Trial Armour Application

Tracked M113 (eight-round turret module installation).

Proposed Armour Applications

Tracked M2/M3 Bradley AFV (eight-round turret module installation) 8 x 8 LAV (eight-round turret module installation).

Manufacturers: Rockwell International, Tactical Systems Division, 1800 Satellite Boulevard, Duluth, Georgia 30136, United States of America. Telephone: (404) 497 5269

Martin Marietta Orlando Aerospace, East Sand Lake Road, PO Box 5837, Orlando, Florida 32855, United States of America.

Telephone: (404) 356 2000



Main components of the Rockwell Hellfire modular missile system

Loral Vought Systems Hypervelocity (HVM) Programme

Development/Description

The HVM is being developed as a US Air Force/US Army/US Marine Corps programme to provide a low cost alternative for both guided anti-armour air-to-surface and ground-launched missiles.

The weapon is designed to destroy a target by using its high velocity of about 1524 m/s and tungsten carbide solid nose to penetrate the protective armour.

The variant for ground launching which is required by the US Army and US Marine Corps will be longer ranged and carry a heavier penetrator projectile than the air-launched version.

Guidance will be by the Multifunctional Infra-red Coherent Optical Scanner (MICOS) device located in the rear of the missile near to the rocket motor. This CO² laser sensing unit receives coded pulses containing position information from the launcher platform and transfers it to the HVM's onboard guidance package.



Artist's impression of Loral Vought Systems LOSAT system mounted on modified Bradley chassis launching an HVM

A Forward Looking Infra-Red (FLIR) sensor is used for target acquisition, target and missile tracking whilst the CO_2 laser guidance link is used to transmit the necessary time-coded azimuth and elevation positional data to the HVM in flight.

An all-boost rocket motor is used to accelerate the weapon to hypervelocity speeds with attitude control motors spaced radially around the missile to provide a full three-dimensional manoeuvre capability.

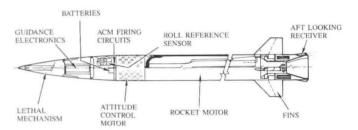
The US Army envisages a potential use on M2/M3 Bradley vehicles whilst the US Marine Corps is interested in equipping its 8 x 8 LAVs.

Another US Army interest is in the future three-man crewed Line-of-Sight Anti-Tank (LOSAT) Vehicle based on FMC Bradley IFV components. This has an elevatable four-round launcher assembly with a further 20 missiles stored within the vehicle body. A simultaneous multi-target engagement capability is a requirement. The first increment of an eventual \$80 million System Design contract was awarded to Loral Vought Systems. In October 1992, Loral Vought Systems was awarded a \$202 million contract to develop and demonstrate new technology for the LOSAT weapon system. Work on this contract will position the programme for the final development phase in 1996. The \$30 million increment covers a 12 month programme through to September 1992 to formulate and integrate the weapon system design into a stretched Bradley IFV chassis.

Missile launch weight is approximately 77 kg, missile length 2.845 m and diameter 0.162 m. Range limits are from around 914.4 to 4572 m.

Status: Development.

Manufacturer: Loral Vought Systems, PO Box 650003, Dallas, Texas 75265-003, United States of America.
Telephone: (214) 266 2011 Telex: 73 303



Outline drawing of Loral Vought Systems Hypervelocity Missile showing position of main components

Hughes BGM-71 TOW

Development/Description

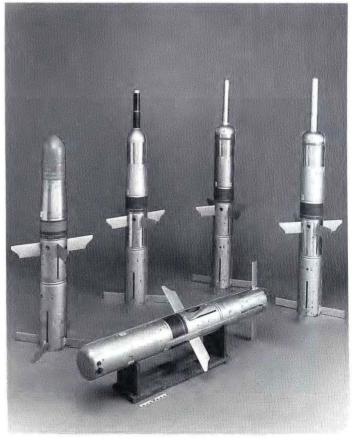
The Hughes BGM-71A Basic TOW (Tube-launched Optically tracked Wireguided) ATGW entered operational service with the US Army in 1970 for use from ground, vehicle and helicopter mounts. It is fitted with Command to Line-Of-Sight guidance (CLOS) and all the gunner has to do is keep the cross-hairs on his sight on the target until the missile impacts.

In 1976 production was switched from the BGM-71A round to the BGM-71B Extended-range Basic TOW variant and then again in 1981 to the BGM-71C Improved TOW which has an enhanced warhead capability to defeat the then new Soviet armour technology that was being fielded at the time. This involves the fitting of a 127 mm calibre warhead with a 265 mm long telescopic nose probe fuze system that pops out when the missile is in flight to give an optimum stand-off penetration capability to the missile's shaped charge. The second phase of the warhead improvement programme, the BGM-71D TOW-2 missile, was introduced in 1983 with a heavier 152 mm calibre warhead, a 345 mm long telescopic nose probe, improved and countermeasures hardened digital guidance and a new propulsion system.

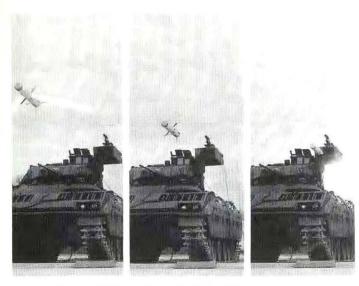
However, in order to defeat tanks fitted with explosive reactive armour blocks, the US Army started an upgrade programme in December 1984 and fielded the BGM-71E TOW-2A variant in 1987. This has an improved direct attack warhead which incorporates a small shaped charge into the extendable nose probe of the TOW-2 to cause a premature explosion in any explosive reactive armour block it hits so that the main warhead charge remains effective in penetrating the conventional armour plate behind. Additional ballast was added to the aft end of the missile to accommodate the extra weight of the new probe, re-designed safe-and-arm device and an electronic timing device to provide the necessary delay between the tip and main charges.

Following initial development work started in 1987 it was announced in April 1988 that Hughes Aircraft had been awarded a contract for full-scale development of the BGM-71F TOW-2B ATGW. The contract, valued at \$35 million, was awarded to Hughes by the US Army Missile Command. The missile entered service in 1991.

The TOW-2B (formerly the TOW lethality improvement programme) is a product improved variant with an Overflight Top-Attack (OTA) capability. It is fitted with two downward firing Aerojet Electro Systems Explosive Formed Projectile (EFP) warheads and the THORN-EMI dual mode active optical laser altimeter and magnetic sensor fuzing device (see FITOW variant later) in a redesigned forebody ahead of the rocket motor unit.



Hughes Aircraft Company's TOW family of anti-tank missiles clockwise from left are the Basic TOW, Improved TOW (ITOW), TOW-2, TOW-2A and in the foreground the new fly-over shoot-down TOW-2B



US Army Bradley IFV launching a TOW-2B ATGW

The warheads are aligned in parallel so that they provide independent shot lines. An advanced guidance programme has been developed which is automatically initiated as the TOW-2B round leaves the launch tube. The gunner still places his cross-hairs on the target but the missile is now biasly commanded to fly at a set height above the line-of-sight so that OTA can OCCUL

Under contract to Missile Command, Hughes Aircraft Company has completed development of a wireless command link for the TOW ATGW. Successful firing trials of this were carried out at Redstone Arsenal in Huntsville, Alabama, in mid-1988. Instead of using fine steel wires that pay out from two bobbins in the back of a conventional TOW missile, guidance commands were sent from the launch station to the missile via a secure millimetre-wave data link.

The test programme used TOW-2 missiles modified to include the millimetre-wave receiver, antenna and processor in place of the wires and bobbins. The TOW-2 launcher was modified with a millimetre-wave transmitter and antenna and an additional electronics card. The weight of the wireless hardware in the missile was less than that of the wires and bobbins. A production version would incorporate a larger rocket motor and have a typical engagement range of 5000 m.

Under contract to the British MoD THORN-EMI of the UK has developed the UK Further-Improved TOW (FITOW) which uses a THORN-EMI fuze and Royal Ordnance top attack warheads. This was developed for the Lynx helicopters of the Army Air Corps and is being retrofitted to existing missiles

The FITOW variant uses a THORN-EMI forebody with a dual mode fuzing device. This comprises an active optical laser altimeter that measures the profile of the terrain being overflown and fires two near-vertically aligned shaped charge warheads into the top of the target when it detects the profile of a tank and the onboard magnetometer sensor confirms the presence of a large metallic mass (so as to prevent unwanted firings against decoys and so on). The target vehicle can be approached by the missile from any direction. Hughes has also modified the missile guidance loop so that FITOW flies above the gunner's line-of-sight in order to permit the OTA flight profile.

Light Armored Vehicle (8 × 8) of US Marine Corps with same twin TOW launcher as fitted to Improved TOW Vehicle (ITV)

For fitting to 127 mm calibre warhead TOW variants TAAS - Israel Industries has developed a replacement tandem warhead unit that is specifically designed to defeat ERA equipped tanks. A spring loaded retractable probe is fitted which extends upon launch. It has a precursor PBX HE charge at its tip which is triggered at the optimum stand-off distance by an active laser proximity fuze. This 'neutralises' the overlying protective ERA layer and allows the main protected warhead charge, comprising a precision shaped PBX HE charge and copper liner, to explode and penetrate the tank's actual armour plate located beneath.

TOW has seen extensive combat use in a number of conflicts including Angola, Chad, the 1973 Yom Kippur War, Lebanon, the Iran-Iraq War, the Thai-Cambodian border skirmishes, the Thai-Laotian border skirmishes, the Vietnam War and the 1991 Gulf War.

In the latter conflict a number of countries used the TOW system. The US Army/US Marine Corps alone shipped some 50 000 rounds into the theatre of operations, of which over 3000 (primarily TOW-2 and TOW-2A) were fired at a wide variety of targets varying from T-72 MBTs to machine gun emplacements and individual snipers.

In the Battle of Khafji counter-attacking Saudi Arabian TOW gunners alone destroyed 46 armoured vehicles, whilst assisting US Marine Corps Cobra helicopters helped destroy a further 20 tanks and APCs.

By late 1992 over 540 000 had been built including 314 000 -BGM-71A/B, 60 000 + BGM-71C, 80 000 + BGM-71D and 80 000 + BGM-71E.

SPECIFICATIONS

wire-guided SACLOS LENGTH BGM-71A/B 1,16 m BGM-71C probe folded 1.17 m. probe extended 1.41 m BGM-71D/E probe folded 1.17 m, probe extended 1.51 m BGM-71F 1.166 m

0.152 m DIAMETER WING SPAN 0.46 m LAUNCH WEIGHTS

BGM-71A/B 18.9 kg BGM-71C 19.1 kg BGM-71D 21.5 kg BGM-71E/F 22.6 kg

WARHEAD BGM-71A/B/C 3.9 kg (2.63 kg HE) HEAT

BGM-71D/E/F 5.9 kg (3.6 kg HE) HEAT

65-3750 m RANGE ARMOUR

PENETRATION BGM-71A/B 600 mm BGM-71C 800 mm (estimated) BGM-71D 900 mm

BGM-71E 1000 mm and a layer of explosive reactive armour

SPEED 278 m/s

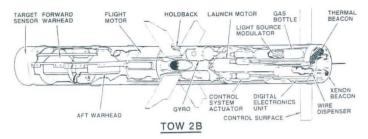
Status: BGM-71A/B production complete. In service with Bahrain, Canada, Chad, Colombia, Denmark, Ethiopia, Germany, Greece, Iran, Iraq, Israel, Italy, Jordan, Kenya, South Korea, Kuwait, Lebanon, Luxembourg, Morocco, Netherlands, Norway, Oman, Saudi Arabia, Somalia, Spain, Taiwan, Thailand, Tunisia, UNITA movement, UK, USA and Yemen.

BGM-71C production concluding. In service with Botswana, Egypt, Finland (as M 83), Greece, Israel, Italy, Japan, South Korea, Kuwait, Netherlands, Pakistan, Saudi Arabia, Spain, Sweden (as Rb55), Thailand, Turkey, UK and USA.



RAMTA Improved TOW Vehicle of Israeli Army with launcher elevated

VEHICLE-MOUNTED ANTI-TANK GUIDED WEAPONS / USA



Cutaway drawing of TOW-2B showing position of main components

BGM-71D in production. In service with Bahrain, Belgium, Canada, Denmark, Egypt, Finland, Germany, Italy, Netherlands, Norway, Pakistan, Portugal, Saudi Arabia, Singapore, Spain, Sweden, Switzerland (licensedbuilt), Thailand, Turkey and the USA.

BGM-71E in production. In service with USA, Canada and several other countries

BGM-71F in production. In service with USA.

Armoured Vehicle Applications

Tracked M2/M2A1/M2A2 (twin-tube turret launcher - 3682 being delivered to US Army)

Tracked M3/M3A1 (twin-tube turret launcher - 3300 being delivered to US Army)

Tracked M113 series (single-tube launcher - Danish (50 plus), Egyptian (50 plus), Greek (83), Israeli (500 plus), Italian (300), Portuguese (18), Somalian (24), Thai (50 plus), Tunisian (47), Turkish (100 plus) and US (1400) Armies))

Tracked M901 (twin-tube ITV turret launcher - Egyptian (52), Greek (50), Jordanian (34), Kuwaiti (unknown number), Pakistani (38) and US Armies (2500 being delivered upgraded to M901A1 standard for TOW-2 launch

Tracked VCC-1 (twin-tube ITV turret launcher - 224 with Saudi Arabian

Tracked Jaguar 2 (single-tube launcher - 162 with Germany Army)

Tracked YPR-765 PRAT (twin-tube ITV turret launcher - 292 with Dutch

Tracked NM142 (twin-tube Kvaerner-Eureka turret launcher - 96 out of 250 planned with Norwegian Army, this version is also in service with Canadian Armed Forces on M113A1 APC)

Tracked Pvrbv 551 (single-tube launcher - 50 plus with Swedish Army)

Tracked AIFV (single-tube launcher - Taiwanese Army)

Tracked M42 Mod (single-tube launcher - Taiwanese Army)

Tracked Wiesel Airportable Vehicle (single-tube launcher - 210 plus delivered to German airborne troops)

8 × 8 LAV(AT) (twin-tube ITV turret launcher - 96 with US Marine Corps)

6 x 6 MOWAG Piranha (twin-tube Kvaerner-Eureka turret launcher - 310 being delivered to Swiss Army)

4 × 4 RBY Mk-1 (single-tube launcher - Israeli Army)

4 x 4 Commando V-150 (single-tube launcher - Saudi Arabia National Guard (50 plus) and Taiwanese Army)

6 × 6 M8 Mod (single-tube launcher - 20 with Colombian Army).

Armoured Vehicle Trial Applications

Tracked Talbot M41E (twin-tube ITV turret launcher)

Tracked OTO C13 (twin-tube ITV turret launcher)

Tracked KIFV (single-tube launcher)

Tracked Type 59 MBT (twin-tube Kvaerner-Eureka turret launcher)

6 x 6 Cadillac Gage V-300 (twin-tube ITV turret launcher)

4 x 4 Cadillac Gage Commando Scout (single-tube launcher)

4 x 4 RAM V-1 (single-tube launcher).

In June 1991 Hughes was awarded a \$50.5 million contract for 4500 advanced TOW missiles, 2000 TOW-2A and 2500 TOW-2B, to replace rounds used in the Gulf War in operations and training. This contract is in addition to one awarded in March and April 1991 that calls for the production of 8404 TOW-2B, 1591 TOW-2A and 854 other TOW models. Total cost of this contract is \$199.1 million with deliveries to be completed by December 1992. The June contract is due to be completed in March 1993.

Manufacturer: Prime contractor: Hughes Missile Systems Company, 8433

Fallbrook Avenue, Canoga Park, California 91304, USA.

Telephone: (818) 702 1000 Telex: 910 4944 997

Fax: (818) 702 34 43

Automatic Loaders and Flick Rammers

AUSTRIA

Intertechnik 155 mm M109 Rammer

Development/Description

Intertechnik has developed a rammer for installation in the BMY 155 mm M109 series of self-propelled howitzers to enable projectiles up to 1 m in length to be loaded and rammed much faster than the current manual method, so enabling a higher rate of fire to be achieved.

Features of the system, which have already been trialled and offered by BMY as part of its Howitzer Improvement Programme (HIP), include microprocessor control and two emergency stop buttons. It is also provided with an integral autotest unit for both automatic and manual operation so as to reduce demands on the turret crew.

All of the motion sequences are hydraulically controlled and monitored

via position switches. The energy required by the semi-automatic loading system can be obtained from the vehicle's existing DC/hydraulic unit.

SPECIFICATIONS

RAMMING ELEVATION

-5° to +45°

RATE OF FIRE burst

3 rds/15 s

sustained

6 rds/min

Status: Development complete. Ready for production.

Manufacturer: Intertechnik, Industriezeile 56, P B Box 100, A-4040 Linz,

Austria.

Telephone: (0732) 2892 Fax: (0732) 2892-123 Telex: 02-1522 HIS A

FRANCE

Mecanique Creusot-Loire Automatic Loader for Leclerc MBT

Development

Mecanique Creusot-Loire is the prime contractor for the automatic loading system which is installed in the Giat Industries Leclerc MBT which is currently in production for the French Army with first vehicle completed in December 1991.

Description

The Mecanique Creusot-Loire automatic loader is installed in the turret bustle of the Leclerc MBT and is separated from the two-man (commander and gunner) crew compartment by a tight armoured wall. Ammunition with combustible cartridge cases is fed to the Giat 120 mm smooth-bore gun when required and a door opens in the armoured wall to allow the ammunition to pass through. In the event of a round hitting the turret bustle, the main force of the explosion will be vented upwards rather than into the crew compartment.

The Leclerc automatic loader consists of two main components: a conveyor in which are stored the 120 mm rounds of ammunition with their noses facing the front of the tank and a telescopic rammer to transfer the ammunition from the loader to the open breech of the 120 mm smooth-bore gun.

The loader can accommodate any type of Giat 120 mm ammunition, including APFSDS and HEAT multi-purpose. The prototype loader was shown in 1987 holding a total of 22 complete rounds of ammunition. The conveyor can be loaded manually from the inside or outside of the Leclerc and, in addition to the 22 rounds of ready-use ammunition, a further 18 rounds are carried inside the tank and loaded into the automatic loader when required by the tactical situation.

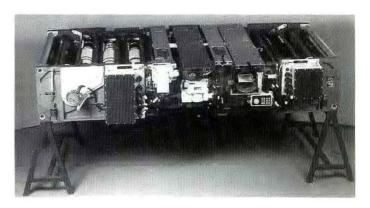
The automatic loader is operated by an electronic system connected to the data bus.

The conveyor system includes an endless chain consisting of a combination of two opened and articulated cells which slide on tracks through the panels, motorised transmission system for automatic selection and transmission mechanisms for manual selection.

The telescopic rammer includes a sliding block and finger to push the ammunition to the open breech of the 120 mm smooth-bore gun, a motorised transmission mechanism for automatic loading and a transmission mechanism for manual loading.

The loading door unit is fitted on the armoured wall and consists of an electrically operated loading door supplying the conveyor, and a transmission mechanism for manual loading.

An ammunition supply system is fitted on the loader. It is manually operated from inside and from outside the turret through an aperture in the turret rear. The ammunition stored is recognised automatically by two bar code sensors fitted on the conveyor.



Mecanique Creusot-Loire automatic loader for Leclerc MBT from the rear

Electronic components include a 16 bit micro-computer which controls the whole loading sequence, an electric power box which supplies the motors, connection box, electrical supply converter box and a small electrical box which is used when an external power supply is required.

The main functions of the control mechanism are to supply the conveyor with testing memorisation, load the 120 mm gun with the correct ammunition, exchange information with the turret computer, control the conveyor chain bi-directional movement, control all movements of the rammer, open and close the loading door, select automatic or manual modes and monitor automatic test sensors and actuators.

The loading sequence is as follows: selection of the correct ammunition, opening and closing of the loading door, the round then rammed in the open breech, rammer withdrawn and breech closed prior to the gun being fired. Once the gun has been fired it automatically returns to -1.8° for loading again.

The 120 mm gun can be loaded when the tank is on a slope or gradient from -15 to $+15^{\circ}$.

A reversionary mode of operation is provided to deal with the failure of a sensor or actuator, while maintaining full automation of the remaining functions.

For MBTs other than Giat Industries Leclerc, the automatic loader can be modified by adding or deleting conveyor cells in order to adapt the automatic loader size to the room available in the turnet bustle.

Status: In production for Giat Industries Leclerc MBT.

Manufacturer: Giat Industries/Mecanique Creusot-Loire, 13, route de la Miniere, F-78034 Versailles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 07 39 00

SPECIFICATIONS NUMBER OF ROUNDS	LENGTH	WIDTH	HEIGHT	WEIGHT WITHOUT AMMUNITION	
22 POWER SUPPLY POWER CURRENT	1.4 m 24 V DC	2.4 m	0.5 m	500 kg	
MAX	110 A				

GERMANY

KUKA Load Assist Device for 155 mm Artillery Systems

Development/Description

This has been developed by Eidgenössische Waffenfabrik Bern (WF) for installation on towed and self-propelled 155 mm howitzers in order to increase their rate of fire at the same time as reducing the workload of the crew. For trials purposes it has already been installed on an M109 series 155 mm self-propelled howitzer.

The load assist device enables the automatic lifting of the round via a loading tray mounted on the left side of the breech, automatic centring of the projectile to the ordnance and automatic ramming of the projectile with constant ramming power. All types of 155 mm projectile can be loaded with the constant ramming power also increasing firing accuracy

The load assist device is electrically controlled and hydraulically operated and consists of mechanical, hydraulic and electrical components.

The mechanical components include the support, loading tray and gear which form the basis of the hydraulic and electric components and at the same time define the geometric position during movement.

The hydraulic components, including the valves, cylinders and cable lines, allow individual movements including lifting, centring and ramming.

The electrical components include the control box, electromagnets, limit switch and circuits which control the movement. Two programmes can be pre-selected.

SPECIFICATIONS

RAMMING ELEVATION

-2.5° to +72° 200 kg (approx)

WEIGHT RATE OF FIRE

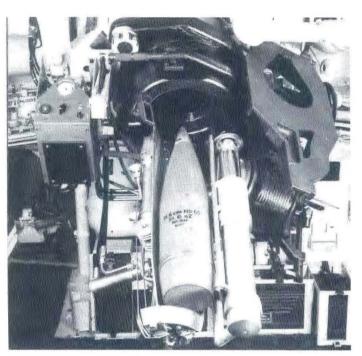
burst

3 rds/15-20 s

sustained

6 rds/min

Status: Development complete. Ready for production.



KUKA load assist device installed in a 155 mm M109 series self-propelled howitzer with projectile on loading tray

Manufacturer: KUKA Wehrtechnik GmbH, Zugspitzstrasse 140, PO Box

431369, D-8900 Augsburg, 43, Federal Republic of Germany.

Telephone: (0821) 797-0 Telex: 53838-40 Kuk d

Telefax: (0821) 797-1207

SWITZERLAND

SFAW/SIG Flick Rammer

Development

This flick rammer has been developed as a private venture by the Swiss Federal Armament Works (SFAW) and the Power and Transmission Control Division of the Swiss Industrial Group (SIG).

The flick rammer has been developed for use with medium calibre artillery to increase the rate of fire, and achieve higher overall rates of fire, give consistent reliability of loading cycles, smoother ammunition handling, remote-control of weapon systems, reduction in manning levels and easier loading in confined spaces such as that associated with artillery systems.

For trials purposes the flick rammer has already been evaluated on an upgraded M109 series 155 mm self-propelled howitzer of the Swiss Army and a 155 mm Swiss fortress artillery system. It can also be fitted to towed or auxiliary propelled field guns and howitzers.

Description

The SFAW/SIG flick rammer accelerates the round on the loading tray hydraulically over the short distance of 200 to 300 mm, with the projectile then covering the remaining distance into the chamber cone in free flight. This principle allows both high rates of fire and constant ramming depths at all angles of elevation and with a variety of projectile types. The SFAW/SIG flick rammer allows a three-round burst of fire in 14 seconds.

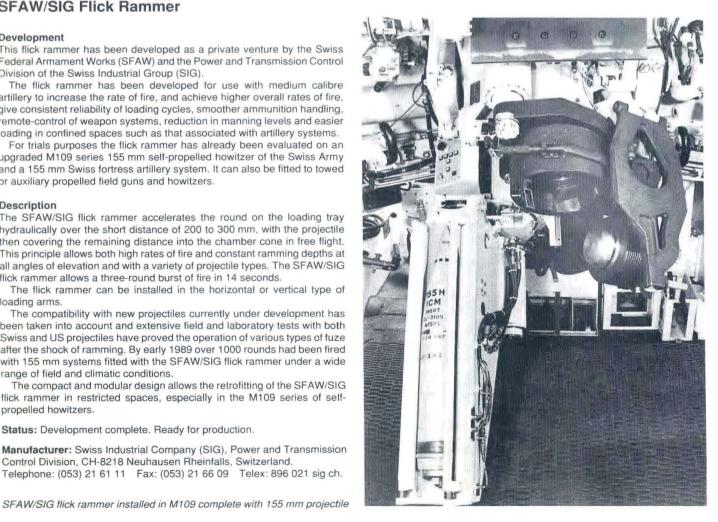
The flick rammer can be installed in the horizontal or vertical type of loading arms.

The compatibility with new projectiles currently under development has been taken into account and extensive field and laboratory tests with both Swiss and US projectiles have proved the operation of various types of fuze after the shock of ramming. By early 1989 over 1000 rounds had been fired with 155 mm systems fitted with the SFAW/SIG flick rammer under a wide range of field and climatic conditions.

The compact and modular design allows the retrofitting of the SFAW/SIG flick rammer in restricted spaces, especially in the M109 series of selfpropelled howitzers.

Status: Development complete. Ready for production.

Manufacturer: Swiss Industrial Company (SIG), Power and Transmission Control Division, CH-8218 Neuhausen Rheinfalls, Switzerland. Telephone: (053) 21 61 11 Fax: (053) 21 66 09 Telex: 896 021 sig ch.



UNITED KINGDOM

Fairey Hydraulics Autoloaders

Development

Details of the first Fairey Hydraulics Autoloader, delivered to RARDE in 1987, were given in the 1989-90 edition of *Jane's Armoured Fighting Vehicle Systems*, page 57. In addition, the company is working on the design and development of alternative types of autoloader concepts for the British MoD and the US Department of Defense.

Late in 1990 Cadillac Gage Textron awarded Fairey Hydraulics a contract worth around \$4 million for the design, development and construction of an automatic loading system for the 105 mm Assault Gun version of the Light Armoured Vehicle for the United States Marine Corps. By the Summer of 1991 the first prototype of this bustle-mounted automatic loader had been delivered to Cadillac Gage Textron for integration into the two-man LAV-105 turret and by late 1991, the autoloader was up and running. In October 1991, however, the US Marine Corps informed Cadillac Gage Textron that it was terminating development of the LAV-105 due to lack of production funds between FY93 and FY95. The development phases remain fully funded, however, and the USMC is expected to restart the programme during FY93.

In February 1991 the British MoD placed a new contract with Fairey Hydraulics Limited for the design and manufacture of a second Bustle Autoloader to support the technology demonstrator phase for the Future Tank Main Armament (FTMA) programme. The UK FTMA Bustle Autoloader was delivered to the Defence Research Agency, RARDE (Chertsey) in August 1992 after successful completion of stand-alone demonstrations. It is intended that the continuing trials programme should include vehicle integration and live firing.

In addition to these developments of autoloaders for high velocity guns of various calibres, the company has designed automatic ammunition handling and stowage equipment for a number of 155 mm howitzers, both towed and self-propelled. On towed howitzers the activity is confined to load assist devices, but on self-propelled systems the range of designs includes full automation from resupply to loading.

Bustle Autoloaders

The FTMA Bustle Autoloader has the capability of handling the 140 mm FTMA ammunition in three principal modes:

- a full autoloader cycle for loading ammunition from the autoloader directly into the gun
- (2) ammunition replenishment from the rear and front of the autoloader
- (3) downloading ammunition from the front of the autoloader.

The new autoloader meets specific requirements for rapid operation, ruggedness, high reliability and minimum weight. Key features of the design are: ammunition is stowed in a bi-directional conveyor providing minimal retrieval delay for the next round; ammunition is securely clamped to prevent chafing; there is provision for partial or full emergency manual reversion; the conveyer belt carries no electrical components so there are no brush connections to wear out; each round is supported by a tubular bridge between the magazine and the breech for reliable ramming on the move; the magazine can be replenished from inside or outside the MBT.

The heart of the mechanism is a conveyor comprised of a number of open-ended tubes. On both ends of each tube are bearings for guidance and support and these follow grooves cut in the two sturdy end plates. Each tube contains mechanisms for clamping the round within it. At one position on the track both ends of the tube align with holes in the end plates. These are in line with the ribbon rammer which effects the transfer of rounds between the magazine and the breech. Another aperture in the rear end plate allows the magazine to be replenished from the rear of the bustle, and permits the expulsion of unwanted rounds.

The conveyor, rammer and the blast protection door through to the crew

compartment are all driven by brushless DC motors. The servo loops use encoders and other transducers to provide feedback to a single microprocessor which provides servo control, safety interlocks and other sequencing, ammunition sensing and external interfacing. A variety of electronic interfaces can be provided, such as MIL-STD 1553. This permits remote operation from a multi-role crew station, complete with automatic selection of ammunition type and full access to the built-in-test facilities.

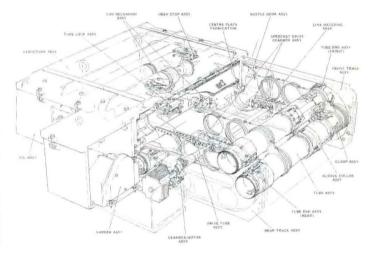
The FTMA autoloader design is readily adaptable to the standard ammunition of the 120 mm smooth-bore guns and, in the process, there are considerable reductions in the length of the autoloader, its complexity and its weight. For minimum weight the 105 mm calibre is preferred and, in this case, the Fairey autoloader complete with electronics and wiring comes to just 130 kg.

The low weight of the adaptable autoloader which was originally designed for LAV-105 is the result of applying Fairey Hydraulics' aircraft equipment skills to a rugged equipment for land-based systems. The single most important feature with regard to weight is the use of a single brushless DC motor and gearbox to drive the mechanism on three axes. The lateral movement of the transverse carriage permits alignment with the gun or the ammunition positions in the eight round magazine. Vertical movement of the ammunition transfer tube is used to put ammunition into the magazine or pick it up prior to loading the gun. Fore-and-aft movement of the same 'tube' loads ammunition into the gun or downloads either unused round or spent shell cases. Empty shell cases are ejected at the rear of the bustle, but unused rounds are normally returned to the magazine.

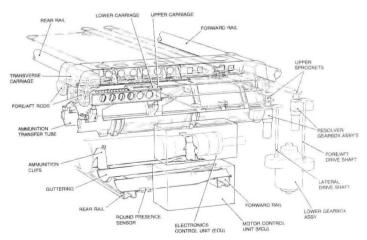
Autoloaders for Artillery

The Fairey Hydraulics' designs range from shell load assist devices (equally applicable to towed and self-propelled howitzers) to fully automated ammunition stowage and handling systems. In a completely automated system it is normal for the gun compartment to be unmanned throughout both firing and replenishment of the magazine, but systems can be designed to utilise varying degrees of manual activity in either process.

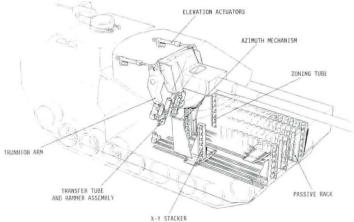
The system illustrated in the drawing has 120 stowage positions for 155 mm projectiles or uni-modular charges. These are normally allocated as 60 projectiles and 60 top charge equivalents, but the proportion assigned to propellant can be reduced if required.



Fairey Hydraulics bustle autoloader for 120 mm (rifled bore) ammunition



Fairey Hydraulics lightweight 105 mm bustle autoloader



Fairey Hydraulics autoloader for 155 mm projectiles and uni-modular charges

In the extreme case a magazine of this type could be configured entirely for projectiles if a different handling system was employed for propellant (for example, bad charges or LP). The ammunition is stowed vertically in passive racks which are formed from energy absorbent material. Each unicharge module is individually supported and clamped for secure storage during vehicle movements and there are multiple clamps on each projectile. Ammunition is retrieved from the racks by the X-Y stackers and presented to the azimuth mechanism. That rotates to match the current position of the turret and releases the ammunition to the trunnion arms, which have built-in rammers. The magazine is resupplied with ammunition at the rear of the vehicle, either automatically or manually, and the X-Y stackers distribute the ammunition to the vacant positions in the magazine.

The system uses some of the techniques which were proved on the Lightweight 105 mm Bustle Autoloader. This keeps the combined weight of the magazine and the replenish/retrieval system to only 67 per cent of the maximum stowed weight of ammunition. This has not necessitated any performance sacrifice: the loading system sustains a firing interval of just five seconds, and an empty magazine can be replenished in ten minutes. Alternatively, the X-Y stackers may be operated to allow firing of feed-through ammunition.

Manufacturer: Fairey Hydraulics Limited, Claverham, Bristol BS19 4NF, United Kingdom.

Telephone: 0934 835337 Telex: 444518 Fax: 0934 835337

UNITED STATES OF AMERICA

United States Tank Automatic Loader Developments

Overview

The German/United States MBT-70 tank had a bustle automatic loader and since then work has continued on a variety of automatic loading systems for MBTs. These have included systems for the US Army's Tank Test Bed (TTB) and Manned Weapon Station (MWS) programmes, neither of which entered production.

A prototype of the TTB was built on a modified M1 MBT chassis which featured a three man crew who were all seated at the front of the hull and provided with roof-mounted observation and surveillance devices. The main armament was mounted externally and the turret basket used for the automatic loader and ammunition stowage. The system had a number of drawbacks including no provision for manual operation.

More recently, the Benet Laboratories have been working on bustlemounted automatic loaders. These have included a bustle-mounted automatic loader for the XM291 Lightweight 120 mm Tank Main Armament System which was fitted to an M1 MBT chassis for firing trials.

This was followed by the 140 mm Advanced Tank Cannon System (ATAC), four prototypes of which have been built by Watervliet Arsenal. One of these ATAC was installed on an M1 Abrams MBT chassis in 1990 to test its interoperability with an automatic loader designed to handle the ATAC separated ammunition system (projectile and charge).

The associated bustle automatic loader has been designed by Benet Laboratories and built at Watervliet Arsenal and incorporates a General Electric ammunition transfer mechanism.

This will be followed by the Abrams-based Component Advanced Technology Test-Bed (CATTB) which will have ATAC as well as the Advanced Integrated Propulsion System (AIPS), expanded M1A1 fire control system, CDC stabilisation controller and a Cadillac Gage Textron weapon stabilisation gear.

Brunswick Defense Automatic Rammer

Development

In September 1990, Brunswick Defense announced that, following extensive trials with a 'proof of principle' system, they had supplied the US Army with three prototype automatic rammers. These are being used for trials and development work with the US Army's new 140 mm smooth-bore Advanced Tank Cannon System (ATAC) built by Watervliet Arsenal

The ATAC is being incorporated into the TACOM Component Advanced Technology Test-Bed (CATTB) based on an M1 MBT chassis with a number of improvements.

Description

The Brunswick Defense automatic rammer is based on a thin foil boom technology that the company originally developed for the Viking Mars Lander and is now being adopted for a number of other applications.

It can move a 38 kg projectile some 3.048 m from a bustle-mounted magazine to the breech in 1.5 seconds, with the total weight of the system being 11.34 kg.

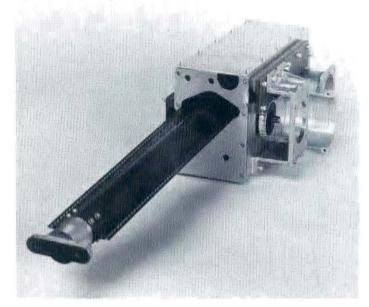
The thin foil boom is a lightweight, tube-like structure that exhibits high column load strength, can be extended and retracted, has very low storage volume and can operate at extremes of temperatures.

The prototype rammer does not have a round retraction capability although this could be incorporated if required by the user.

Status: Prototype systems undergoing US Army trials.

Manufacturer: Brunswick Corporation, Defense Division, 3333 Harbour Blvd, CS 2009, Costa Mesa, California 92628-2009, USA.

Telephone: (714) 546 8030 Fax: (714) 434 7492



Brunswick Defense tank ammunition rammer with thin foil boom extended into ramming position

Vista Controls M109 Robot: Pneumatic Rammer

Development/Description

In mid-1991, the US Army Armament Research, Development and Engineering Command awarded Vista Controls a contract to build a new all electric robotic autoloader for the 155 mm M109 howitzer demonstration unit. This will transfer projectiles and charges from storage areas in the M109 to the ordnance, so providing it with a completely automatic loading capability. According to the company, its new robotic loader will be faster and more versatile than the robot currently used for the M109 demonstrator.

A goal of the new robot will be the capability of loading any type of charge (for example, powderbags, unicharges or liquid propellant) and then selecting from a variety of rounds (for example Copperhead or HE) to complete the loading procedure.

Vista's SCOREboard™-based AECU (Advanced Electronic Control Unit) controller is currently operating the existing demonstration M109's robot. The AECU is a closed loop servo-controller that is the first known implementation of high performance RISC technology to military robotic application, performing complex motion calculations at rates as high as 2000 Hz. Vista's SCOREboard™ Family is the first use of RISC technology in a MIL-SPEC system available as a Non-Developmental Item (NDI) product.

Status: Development.

Manufacturer: Vista Controls Corporation, 27825 Fremont Court, Valencia, California 91355, USA.

Telephone: (805) 257 4430

Ammunition

ARGENTINA

Argentinian Ammunition

The facilities of the Direccion General de Fabricaciones Militares manufacture a wide range of small arms and artillery ammunition for both the home and export markets including the following types:

20 mm FMK 1 MOD 0 PET (Perforante Explosivo Trazante)

20 mm FMK 2 MOD 0 ET (Explosivo Trazante)

20 mm FMK 3 MOD 0 Practice

20 mm FMK 4 MOD 4 EJT (Ejercicio Trazante)

20 mm FMK 11 MOD 0 Dummy

20 mm FMK 12 MOD 0 EJ (Ejercicio)

30 mm FMK 1 MOD 0 EJT (Ejercicio Trazante)

30 mm FMK 2 MOD 0 INS (Instruccion) (training round)

30 mm FMK 3 MOD 0 EJ (Ejercicio) (for Mirage fighter aircraft)

30 mm FMK 4 MOD 0 EINC (Explosivo Incendiario)

40 mm FMK 1 MOD 0 SPET (Semiperforante Explosivo Trazante)

40 mm FMK 2 MOD 0 EJT (Ejercicio Trazante)

40 mm FMK 3 MOD 0 ET (Explosivo Trazante)

40 mm FMK 4 MOD 0 (n/a)

105 mm EF (Explosivo de Fragmentacion) (for AMX-13 light tank with 105 mm gun)

105 mm HINC (Humoso Incendiario) (for AMX-13 light tank with 105 mm

gun) 105 mm EJ AT (Ejercicio Antitanque) (for AMX-13 light tank with 105 mm

gun) 105 mm EF (Explosivo de Fragmentacion) (for OTO Melara 105 mm Pack

Howitzer)
105 mm HINC (Humoso Incendiario) (for OTO Melara 105 mm Pack Howitzer)

155 mm EF (Explosivo de Fragmentacion) (for AMX 155 mm Mk F3 self-propelled gun and 155 mm Models 77 and 81 howitzers)

Manufacturer: Direccion General de Fabricaciones Militares, Cabildo 65, Buenos Aires, Argentina.

AUSTRALIA

Australian Defence Industries Limited

In May 1989 the Office of Defence Production, Department of Defence, was disbanded and its manufacturing assets transferred to the Australian Defence Industries Limited (ADI).

ADI is a private company whose shares are held by the Australian Government. The company, with assets exceeding \$500 million, has expanded its operations through acquisition to become Australia's largest defence company.

Capabilities and techniques: major ship repair, refit, modernisation and maintenance and marine engine manufacture; environmental testing, metrology and electronic calibration; manufacture and refurbishment of small and large weapon systems; precision engineering services in light, medium and heavy areas; training systems including targetry and projectile location systems; design, construction, installation and modernisation of outdoor specialist ranges; design, development and production of ammunition, pyrotechnics, explosive products, rocket motors and propellant; manufacture of military, field and dress uniforms and protective clothing.

It also has: capabilities in the design, development and engineering of extensive electronics systems, subsystems and instrumentation for defence and industry; quality team of defence analysts with extensive Australian and international experience to plan, manage and produce a wide range of consulting services; a wide range of logistics management and support services for defence and industry.

ADI operates a number of munitions facilities and has been involved in the production of ammunition since 1888. A summary of the major activities of each of the facilities is as follows:

Footscray Facility

Manufacture of small arms and medium calibre ammunition, cartridge cases, small calibre projectiles and fuzes (including percussion, mechanical and electronic types), explosives and primers. This facility will be closed in the future.

Bendigo Facility

Manufacture of ordnance, recondition guns and gun mountings, and production of bomb bodies, ammunition clips and links. Also undertaken are gear cutting, fabrication and machining of heavy equipment and precision engineering. This facility will be closed in the future.

Maribyrnong Facility

Manufacture of ordnance including projectiles, bomb bodies, depth charges, missile launchers, generators, specialised pressure vessels, rocket motor hardware, gun mountings, heavy and general engineering items and test equipment for defence applications.

Lithgow Facility

Manufacture of rifles, machine guns and other personal weapons and ammunition components and track pads for the M113 series APC.

Mulwala Facility

Production of nitrocellulose and propellants for various small arms, mortar and large calibre gun ammunition. Production of double base casting powders for the manufacture of rocket motors. Research and development of single, double and triple base propellants as well as commercial powders.

St Marys Facility

Filling and assembly of gun and mortar ammunition, bombs, grenades, mines, warheads, anti-tank rockets, pyrotechnic stores and related components including fuzes, cartridges, detonators and caps.

In addition to the manufacture of a wide range of propellants, the following ammunition is manufactured for armour and artillery applications:

76 mm L25A3 practice

76 mm L24A3 HE-T

105 mm TC800 canister (qv)

105 mm M1 HE

105 mm M60 white phosphorous

105 mm M314A2 illuminating

105 mm M84 smoke HC

105 mm practice

105 mm F1 blank

20 mm M55 practice

12.7 mm Ball F1.

Enquiries for products manufactured by ADI should be addressed to: Chief General Manager, International Marketing Division, Australian Defence Industries Ltd, Level 22, Plaza II, Cnr Grosvenor and Grafton Streets, Bondi Junction, Sydney NSW 2022, Australia.

Telephone: (02) 365 9300 Fax: (02) 369 2404

105 mm TC800 Canister Round

Development/Description

This 105 mm canister round has been developed by Australian Defence Industries (ADI) to meet the requirements of the Royal Australian Armoured Corps for its Leopard 1 MBTs.

The TC800 has been designed to be fired from any MBT armed with a 105 mm L7 or M68 rifled tank gun, although it can also be fired from the 105 mm gun installed in the French AMX-30 MBT.

The TC800 provides MBTs with effective protection against massed infantry attack out to a range of 300 m and, when compared to earlier

generation canister rounds, has much reduced barrel wear. Typically, more than 2000 rounds could be fired before a tank barrel wears out.

The TC800 consists of a brass cartridge containing the propellant with the projectile fitted to the top. When fired the projectile breaks up within 5 m of the muzzle and at the same time spins slowly giving a cone-shaped dispersion within a 10° angle out to a maximum range of 300 m.

During trials in Australia, 12 infantry type targets were set up across a 35 m frontage at a range of 100 m from the tank. Nine of these targets were struck by a total of 31 pellets. The trial was then repeated with 18 targets set up on a 35 m frontage at a range of 20 m and 12 targets were hit.



In addition, the TC800 can also be used against soft skinned vehicles, foliage and barbed wire. Fired at soft skinned vehicles at a range of 50 m, 246 strikes were recorded of which 100 passed through both sides of the vehicle. At a range of 125 m 60 strikes were recorded, while at a range of 200 m 40 strikes were recorded of which six passed through both sides.

One TC800 round fired at dense vegetation defoliated an area of approximately 30 x 25 m and from a range of 15 m; one TC800 round cleared a 2.5 m path through triple concertina barbed wire.

Status: Production. In service with Australian Army.

Manufacturer: Chief General Manager, International Marketing Division, Australian Defence Industries Ltd, Private Bag No 1, Post Office, Deakin ACT 2600, Australia.

Telephone: (61) 6-2859300 Fax: (61) 6-2859325

ADI 105 mm TC800 canister round (Terry Gander)

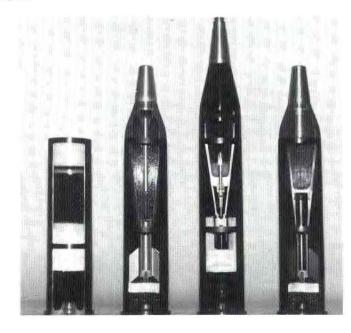
BELGIUM

MECAR Ammunition

The Belgian MECAR concern is a subsidiary of Allied Research Corporation Inc of the USA. MECAR develops, designs and produces technologically advanced weapons systems and ammunition. This includes rifle grenades, mortar bombs, anti-tank ammunition and a variety of tank gun ammunition including APFSDS types.

MECAR Ammunition 90/28 Light Gun System

MECAR produces a range of ammunition for its own 90 mm light gun system. The gun is suitable for mounting in light armoured vehicle turrets or for use as a towed gun on light field mountings. The range of ammunition produced includes HEAT, HE, Smoke and Canister. Training rounds are also produced. Also available is a special training device known as the TD-T-20-90 which fires a special 20 mm round, the TP-T-20-90 M643, which matches the ballistic performance of the HEAT-T round.



MECAR ammunition for lightweight gun 90/28 with graze effect fuzes

Mecar 90/28 Rounds

SPECIFICATIONS Type DESIGNATION	HEAT-T M600	HE-T M601	Smoke-WP-T M612	Canister M607	PRAC (HEAT) M400	PRAC-HE-90 M404	Drill —
WEIGHT total	3.68 kg	5.15 kg	5.15 kg	5.95 kg	3.68 kg	5.15 kg	3.9 kg
projectile	2.44 kg	4 kg	4 kg	4 kg ¹	2.44 kg	4 kg	n/app
LENGTH (projectile)	621 mm	470 mm	470 mm	373 mm ²	600 mm	470 mm	588 mm ³
FILLING	Comp A3	TNT	WP	lead balls	inert	inert	inert
FUZE	PI BD-Graze	PD-Graze	PD-Graze	none	inert	inert	dummy
RANGE							
max	3500 m	6500 m	6500 m	300 m	3500 m	6500 m	n/app
combat	1000 m	4200 m at 20° QE	4200 m at 20° QE	250 m	n/app	n/app	n/app
MUZZLE VELOCITY	633 m/s	338 m/s	338 m/s	360 m/s	633 m/s	338 m/s	n/app

¹Canister contains and fires approx 1120 8.5 mm lead spheres each weighing 3.6 g

Note: There are also the Smoke M602 and the sub-calibre TP-T-20-90 (M643) rounds.

90 mm Ammunition for Cockerill KEnerga Mk 8 Gun

MECAR has developed a new range of ammunition to be used with the Cockerill Mk 8 gun. This range, currently in production, comprises APFSDS-T, HESH-T and Smoke (WP), but other natures are now under development.

The M690 APFSDS-T projectile will penetrate a NATO standard medium heavy target at a range of 2000 m.

SPECIFICATIONS (alu Type DESIGNATION WEIGHT	minium case) APFSDS-T M690	HV-HEAT-T M644	HEAT-T M626	HESH-T M691	HE M627	Smoke-WP-T M693	CNT M629
total projectile penetrator	12.7 kg 3.7 kg 2.05 kg	7.75 kg 4.09 kg	8.22 kg 5.04 kg	14.2 kg 7.2 kg	8.27 kg 5.04 kg	14.2 kg 7.2 kg	8.25 kg 5 kg
charge FILLING TYPE OF FUZE	3.3 kg n/app n/app	1.84 kg Comp A3 PI BD/graze	1.4 kg Comp A3 PI BD/graze	1.6 kg Comp A3 BD/graze	1.4 kg Comp B PD/graze	1.6 kg WP BD/graze	1.4 kg 1094 lead spheres delay (7 m) (after muzzle)
LENGTH complete round projectile RANGE (combat) MUZZLE VELOCITY	959 mm 524 mm 2500 m 1300 m/s	823 mm 544 mm 1200 m 1020 m/s	843 mm 624 mm 1000 m 780 m/s	950 mm — 1000 m 700 m/s	782 mm 488 mm 1000 m 779 m/s	950 mm — 2000 m 700 m/s	670.5 mm 178 mm 200 m 779 m/s

MECAR 90 mm Ammunition for Cockerill Mark II and III and ENGESA EC-90

MECAR now produces 90 mm ammunition for the Cockerill Mark II and III guns and also for the ENGESA EC-90 gun. The MECAR ammunition differs from the then PRB ammunition that is normally supplied for the Cockerill and EC-90 guns in using aluminium for the cartridge case and a graze action fuze that will operate at striking angles as small as 2°. The full range is given in the Specifications table but the smoke projectile can be supplied with either WP or titanium tetrachloride fillings and practice rounds are available for all types except canister. All types are now in production. In August 1989 MECAR announced that a country in the Middle East had awarded the company a contract worth \$8 million for the supply of M652 APFSDS-T ammunition and a conversion kit to allow the existing Cockerill 90 mm Mark III gun to fire the new round. Details of the latter are given in the AFV Armament section. This was the first order for the muzzle brake conversion package.



MECAR 90 mm ammunition for Cockerill Mark II and III and ENGESA EC-90 guns, from left to right canister, smoke-T, HEAT-T, APFSDS-T

²case only

³overall length

SPECIFICATIONS Type DESIGNATION WEIGHT	APFSDS-T M652*	HE-T M616	HEAT-MP-T M617**	SMK(WP)-T M618	HEAT-T M620	Canister M621	HESH-T M625
total	7.2 kg	9.04 kg	8.98 kg	9.22 kg	8.3 kg	7.9 kg	8.23 kg
projectile	2.5 kg	5.1 kg	5.07 kg	5.3 kg	4.15 kg	n/av	4.3 kg
propellant	1.8 kg	1.14 kg	1.18 kg	1.13 kg	1.4 kg	1.14 kg	1.2 kg
LENGTH							
round	647 mm	638 mm	702 mm	640 mm	680 mm	526 mm	600 mm
projectile	426 mm	n/av	n/av	n/av	n/av	n/av	n/av
FILLING							
type	n/app	Comp B	Comp A3	WP	Comp A3	spheres	Comp A3
weight	n/app	1.02 kg	0.77 kg	1.12 kg	0.51 kg	5.1 kg	1.2 kg
PROPELLANT	single base	single base	single base	single base	single base	single base	single base
FUZE	n/app	PD/graze	PI BD/graze	PD/graze	PI BD/graze	nil	BD/graze
RANGE							
operational	1800+ m	800 m	800 m	800 m	1000 m	200 m	800 m
effective	n/app	2200 m	1500 m	2000 m	1500 m	n/app	n/app
MUZZLE VELOCITY	1200 m/s	700 m/s	730 m/s	695 m/s	900 m/s	700 m/s	800 m/s

Will penetrate 200 mm of RHA

MECAR 90 mm ammunition for DEFA F1 Gun

MECAR produces ammunition for the 90 mm DEFA F1 gun which is fitted on many light armoured vehicles. Also produced for this gun is a special training device, the TD-20-90 M648, that fires a special 20 mm round, the TP-20-90 M649. This round matches the ballistics of the 90 mm HEAT round

SPECIFICATION	S				
Type	APFSDS-T	HEAT-T	HE-T	Smoke-WP-T	Canister
DESIGNATION WEIGHT	M645	M630	M631	M632	M633
total	6.8 kg	7.1 kg	8.95 kg	9.1 kg	8.9 kg
projectile LENGTH	2.5 kg	3.65 kg	5.28 kg	5.4 kg	5.28 kg
(round) FILLING	645 mm	655 mm	638 mm	638 mm	488 mm
(weight)	_	0.67 kg	0.95 kg	0.85 kg	n/a*
RANGE MUZZLE	1300 m	1000 m	1800 m	1800 m	150 m
VELOCITY	1050 m/s**	750 m/s	650 m/s	640 m/s	650 m/s

^{*} filling is 1100 lead balls

MECAR APFSDS Ammunition

Development/Description

For some years MECAR has been developing and producing APFSDS ammunition with calibres of 60 mm, 90 mm, 100 mm and 105 mm. The company is now committed to a research and development programme for the supply of 120 mm tank gun rounds.

The 60 mm M300 APFSDS round developed for the OTO Melara 60 mm High-velocity Gun System uses a single-base cool burning propellant and

has a flight time of 0.95 s to a range of 1500 m.

The 90 mm M670 APFSDS is used in the M36 gun mounted in the M47 tank as well as the M41 gun mounted in the M48/M48A1/M48A2 and M48A3 tanks. The M670 has a flight time of 1.36 s to 1000 m with an apogee of 2.2 m.

The 90 mm M652 is used with the Cockerill Mark II and Cockerill Mk III guns as well as the ENGESA EC-90 and has an effective operational range of 1800 m with a flight time to that range of two seconds and an apogee of approximately 3 m.

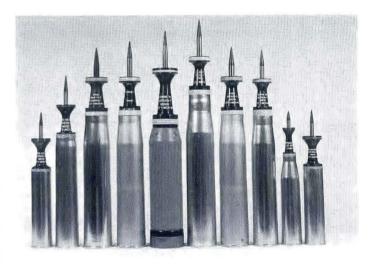
The 90 mm M645 is used with the French DEFA F1 gun and has an effective operational range of more than 1300 m with a flight time to that range of less than 1.4 s and an apogee of approx 2.3 m.

The 100 mm M1000 was developed for use with the former Soviet D-10 series of tank guns and time of flight to maximum range of 2000 m is 1.5 s with the maximum apogee being less than 2.8 m. The M1000 uses a singlebase cool burning propellant.

The 105 mm APFSDS-T M1050 is used with the L7, M68 and CN105 F1 guns and has a muzzle velocity of 1510 m/s and the penetration capability to defeat all NATO heavy tank targets at all ranges.

The MECAR improvement programme has resulted in the production of the 105 mm M1060 APFSDS-T round which has a comparable performance to the US M833 but without the problems associated with depleted uranium.

More recently MECAR has started to develop a 120 mm smooth-bore APFSDS-T round that can be fired from 120 mm smooth-bore guns as fitted to the Leopard 2 and M1A1/M1A2. This round is designated the M1080 and will penetrate over 540 mm of RHA at 0°



The complete range of MECAR APFSDS ammunition now runs from 60 mm up to 120 mm in calibre

Details of the following MECAR APFSDS-T rounds are given in their respective entries in this section:

90 mm M690

90 mm M652

90 mm M645

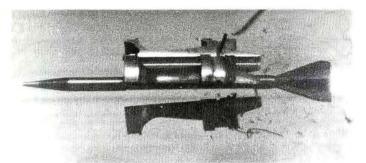
100 mm M1000 105 mm M1050

105 mm M1060

^{**}Will penetrate 350 mm of RHA or 1200 mm of concrete

Training equivalents are available for all of the above except the M621

^{**} will penetrate 70 mm of RHA



MECAR APFSDS projectile with three part saddle separating from the finned projectile

SPECIFICATIONS	S		
CALIBRE	60 mm	90 mm	120 mm
DESIGNATION WEIGHT	M300	M670	M1080
complete round	6.14 kg	13.8 kg	25 kg
projectile LENGTH OF	1.3 kg	3.65 kg	7.2 kg
ROUND	626.5 mm	865 mm	995 mm
PENETRATOR MUZZLE	all have a tung	sten alloy penetrator	
VELOCITY	1630 m/s	1500 m/s	1675 m/s

MECAR 100 mm Tank Ammunition

This ammunition is produced for 100 mm D-10T series rifled tank guns installed in former Soviet T-54/T-55 and Chinese Type 59 tanks.

Туре	APFSDS-T	HE-CAN-100
DESIGNATION	M1000	M1004
WEIGHT		
complete round	21.8 kg	30.71 kg
projectile	5 kg	15.25 kg
penetrator	3.27 kg	n/app
LENGTH		
complete round	1.064 m	1.09 m
penetrator	496 mm	n/app
MUZZLE VELOCITY	1475 m/s	900 m/s
FILLING	n/app	TNT
PROPELLANT	single base	single base
FUZE	n/app	RGM
Former Soviet equivalent		
projectile	n/a,pp	F-412

Notes: M1000 has a tungsten alloy penetrator which will penetrate 150 mm RHA at 60° obliquity at 2500 m, operating temperature -32°C to +52°C

M1004 has a maximum range of 14 600 m

There are also the M1002 and M1003 training devices (20 mm)

Smoke-WP-CAN	HEAT-CAN-100
M1006	M1007
30.71 kg	26.07 kg
15.25 kg	12.15 kg
n/app	n/app
1.08 m	1.095 m
n/app	n/app
900 m/s	900 m/s
WP	RDX/wax
single base	single base
RGM	VP-9
n/app	ZBK-5M

MECAR 105 mm Tank Ammunition

MECAR is now producing under US licence a number of 105 mm tank rounds such as the M724 TPDS-T and the M393A2 HESH. Other developments include the APFSDS-T M1050 which, according to MECAR, is equivalent in performance to the FP 105 mm, the M1060 comparable in performance to the M833. Both of these rounds are intended for use with 105 mm L7, M68 and CN105 F1 guns.

In addition, MECAR is also producing 105 mm rounds such as the M456A2 HEAT-T, M490 HEAT TP-T and the M416 Smoke (WP) intended for the L7 and M68 guns and the M1010 HE, M1009 Smoke (WP) T and the M1008 Illuminating for the CN105 F1 gun.

In early 1989 MECAR was awarded a \$14 million contract from an undisclosed Asian country for the supply of M416 Smoke (WP)-T and M1050 APFSDS-rounds. In early 1990 MECAR was awarded a contract for 105 mm training ammunition for use by Leopard 1 MBTs of the Belgian Army.

SPECIFICATIO	NS
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Туре	APFSDS-T*	APFSDS-T*	FSDS-TP	TPDS-T
DESIGNATION WEIGHT	M1050	M1060	(PRAC) M1056	M724
complete round projectile LENGTH	17.7 kg 5.8 kg	18 kg 5.8 kg	16.1 kg n/av	14.52 kg n/av
round projectile MUZZLE VELOCITY PROPELLANT	927 mm 475 mm 1510 m/s n/av	980 mm n/av 1510 m/s n/av	980 mm n/av 1540 m/s n/av	838.2 mm n/av 1539 m/s M1

may m	av II/av	IVII
HEAT-MP-T**/**	** HESH-T***	Smoke (WP)-T
M1061	M393A2	M416
22 kg	20.42 kg	20.64 kg
990 mm	940 mm	940 mm
1173 m/s	730 m/s	730 m/s
M48	n/av	M48
Comp B	Comp A3	WP
M30	M1	M1
	HEAT-MP-T**/** M1061 22 kg 990 mm 1173 m/s M48 Comp B	HEAT-MP-T**/**** HESH-T*** M1061 M393A2 22 kg 20.42 kg 990 mm 940 mm 1173 m/s 730 m/s M48 n/av Comp B Comp A3



Some of the extensive range of 105 mm ammunition produced by MECAR with APFSDS-T round in centre

74 AMMUNITION / Belgium — Bulgaria

Туре	HE-T*	Smoke (WP)-T*	ILL*
DESIGNATION	M1010	M1009	M1108
WEIGHT			
complete round	20.8 kg	20.8 kg	n/app
LENGTH	990 mm	990 mm	960 mm
MUZZLE VELOCITY	700 m/s	690 m/s	290 m/s
SMOKE DURATION	n/app	40 s	n/app
ILLUMINATION TIME	n/app	n/app	35 s
BURST HEIGHT	n/app	n/app	350 mm
FILLING TYPE	HE	Smoke WP	illuminate
FILLING WEIGHT	2 kg	1.77 kg	0.46 kg
PROPELLANT	all have sing	gle base seven hol	е

* These rounds can be fired with CN105F1, L7 and M68 guns

** The M490 TP-T, with similar technical and ballistic characteristics is the practice version of the HEAT-T-MP M456A2 and M1061

*** The HESH-TP M467, with similar technical and ballistic characteristics is the practice version of the HESH M393A2

**** The M1061 has all of the performance characteristics of the M456A2 but incorporates a modern electronic fuze with graze input function in the fuze itself

Manufacturer: MECAR SA, B-7181 Petit-Roeulx-lez-Nivelles (Seneffe), Belgium.

Telephone: (32) 67/21 77 95 Telex: 574 38

Fax: (32) 67/21 63 07

BRAZIL

Companhia Brasileira de Cartuchos (CBC) Ammunition

This company was founded in 1926 and since 1929 has been producing ammunition for the Brazilian Armed Forces and police. CBC's main production facilities are in Santo André and Ribeirão Pires, both in the State of São Paulo. Current products consist of many calibres of pistol and revolver cartridges: 5.56 mm, 7.62 mm NATO and .30 cal cartridges for rifles, .50 cal cartridges for machine guns, .50 spotter tracer cartridges; 20×110 mm cartridges for Oerlikon cannon; 20×102 mm cartridges for Vulcan guns and 30×113 mm cartridges for DEFA guns.

Early in 1989 CBC announced that it had opened its own single base propellant plant. The plant is equipped to manufacture every type of single base power and this will offer a high quality product with uniform ballistics.

SPECIFICATIONS

20 x 110 mm RB Oerlikon

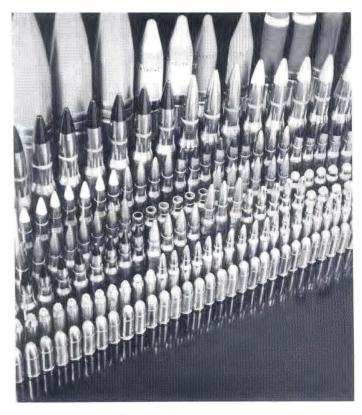
Type WEIGHT	TP	TP-T	HEIT-SD
complete round	251 g	255 g	228 g
projectile	123 g	127 g	101 g
MUZZLE VELOCITY	835 m/s	835 m/s	880 m/s

20 × 102 mm for Vulcan guns

Type WEIGHT	TP M55A2	TP-T M220	HEI M56A3
complete round	260 g	258 g	262 g
projectile	99 g	96 g	100 g
VELOCITY AT 25 m	1000 m/s	1000 m/s	1000 m/s

30 × 113 mm Type 550 for DEFA and similar weapons

Type WEIGHT	TP	TP-T	API	HEI
complete round projectile VELOCITY AT	455 g 245 g	460 g 250 g	485 g 275 g	455 g 245 g
7.5 m	810 m/s	800 m/s	780 m/s	810 m/s



Complete range of CBC ammunition

Manufacturer: Companhia Brasileira de Cartuchos (CBC), Av Industrial 3330, PO Box 51, 09080 – Santo André – SP Brazil.

Telephone: (011) 449 5600 Telex: (011) 44007 CBCA BR

Fax: (011) 454 6470

BULGARIA

Bulgarian Ammunition

The Bulgarian defence industry manufactures a wide range of ammunition for infantry weapons, mortars, armoured fighting vehicles and artillery systems. Details of ammunition with a calibre of 23 mm and above for land systems are covered in this section.

23 mm (for ZSU-23 and ZSU-23-4 anti-aircraft guns)

Туре	APIT	HEIT	HEIT (Inert)
MUZZLE VELOCITY WEIGHT	970 m/s	970 m/s	970 m/s
projectile	190 g	188.5 g	188.5 g

Туре	APIT	HEIT	HEIT (Inert)
cartridge case	172 g	172 g	172 g
propellant	76 g	77 g	77 g
primer sleeve	12 g	12.5 g	12 g
total	450 g	450 g	450 g
LENGTH			
projectile	99.3 mm	108.2 mm	108.2 mm
cartridge case	151.5 mm	151.5 mm	151.5 mm
total	235 mm	235 mm	235 mm
RANGE			
horizontal	2500 m	2500 m	2500 m
vertical	1500 m	1500 m	1500 m

Note: Blank rounds are also produced as are 23 mm AP-T rounds for subcalibre barrels.

57 mm (for S-60 anti-aircraft gun)

Type DESIGNATION	Fragmentation – tracer UOR-281
MUZZLE VELOCITY WEIGHT	1000 m/s
projectile and NTZ-57 fuze	2.656 kg
cartridge case	2.150 kg (steel)
Control of the Contro	2.265 kg (brass)
propellant	1.190 kg
primer	0.086 kg
total	6.35 kg
LENGTH	
projectile	177 mm
fuze	46 mm
cartridge case	348 mm
primer bushing	24 mm
total	535 mm
RANGE	
horizontal	12 000 m
vertical	8800 m

100 mm (for T-54/T-55 MBT, SU-100 assault gun and BS-3 field gun)

Type DESIGNATION FUZE DESIGNATION MUZZLE VELOCITY	HEAT UBK-4 GPV-2 900 m/s	HE UOF-412 U V-429 900 m/s (full charge) 600 m/s (reduced charge)
WEIGHT fuze	0.16 kg	0.438 kg
projectile	12.2 kg	13.8 kg
bursting charge	0.99 kg	1.46 kg
cartridge case	6.00 kg	6.00 kg (steel)
		8.5 kg (brass)
propellant	4.65 kg	5.75 kg or 2.4 kg
primer sleeve	0.09 kg	0.086 kg
total	16.85 kg	30.27 kg or 27.9 kg
LENGTH		
fuze GPV-2	100 mm	106 mm
projectile	360.6 mm	430 mm
cartridge case	695 mm	695 mm
total	1090 mm	1088 mm
POINT BLANK RANGE	1000 m	n/app
MAX RANGE	n/app	16 800 m (full charge)
		11 000 m (reduced charge)

122 mm (for 2S1 self-propelled artillery system)

Type DESIGNATION FUZE TYPE MUZZLE VELOCITY WEIGHT	HEAT	HE	HE
	VBK-3	VOF 462 J	VOF 462 J*
	GPV-3	RGM-2	RGM-2
	690 m/s	690 m/s	565 m/s
fuze projectile body charge cartridge case propellant primer sleeve total projectile total charge LENGTH	0.88 kg	0.438 kg	0.438 kg
	18.7 kg	17.578 kg	17.578 kg
	1.7 kg	3.528 kg	3.528 kg
	3.66 kg	3.66 kg	3.66 kg
	3.8 kg	3.8 kg	2.43 kg
	0.09 kg	0.09 kg	0.09 kg
	18.20 kg	21.55 kg	21.76 kg
	6.325 kg	7.83 kg	6.235 kg
fuze projectile body cartridge case primer sleeve POINT BLANK RANGE MAX RANGE	110 mm	106 mm	106 mm
	628 mm	500 mm	500 mm
	447 mm	447 mm	447 mm
	30 mm	n/av	n/av
	1000 m	n/app	n/app
	n/app	17 360 m	15 300 m

^{*}has reduced multi-section charge.

122 mm (for M-30 howitzer)

Туре	HE
DESIGNATION	VOF 462
MUZZLE VELOCITY	515 m/s (max range 11 800 m)
	290 m/s (max range 6960 m)
WEIGHT	
fuze RGM-2	0.438 kg
projectile	17.6 kg
charge (TNT)	3.528 kg
cartridge case	3.25 kg
propellant	2.1 kg or 0.71 kg
primer sleeve	0.09 kg
total projectile	21.76 kg
total charge	7.85 kg or 6.46 kg
LENGTH	
fuze	106 mm
projectile	506 mm
cartridge case	285 mm
primer sleeve	24 mm

Note: A blank round for training is also available.

125 mm (for 2A46 tank gun in T-72 MBT)

Type	HE
DESIGNATION	3 VOF 22 (projectile is OF 19)
MUZZLE VELOCITY	850 m/s
MAX RANGE	10 000 m
WEIGHT	
V-429E fuze	0.435 kg
projectile body	19.4 kg
TNT charge	3.15 kg
cartridge case	3.84 kg
propellant	5.86 kg
primer sleeve	0.09 kg
total projectile	23 kg
total charge	9.8 kg
LENGTH	09 MAGE 140
fuze	106 mm
projectile	615 mm
cartridge case	387 mm
primer sleeve	24 mm
total projectile	677 mm
total charge	408 mm
-	

Note: A blank training round is also produced.

130 mm (for M-46 field gun)

Туре	HE (with full or reduced charge)
DESIGNATION	VOF 482M
MUZZLE VELOCITY	705 m/s (reduced) (max range 19 130 m) 930 m/s (full) (max range 21 000 m)
WEIGHT	, , , , , , , , , , , , , , , , , , , ,
V-429 fuze	0.438 kg
projectile body	29.20 kg
driving bands	1.22 kg
bursting charge	3.61 kg
cartridge case	11.35 kg
charge	7.6 kg or 14.3 kg
primer sleeve	0.09 kg
total projectile	33.40 kg
total charge LENGTH	25.73 kg
fuze	130 mm
projectile	600 mm
cartridge case	846 mm
primer sleeve	30 mm
total projectile	668 mm
total charge	846 mm

Note: A blank training round is also produced.

152 mm (for D-20 and ML-20 gun-howitzers)

Type	HE
DESIGNATION	VOF 540
MUZZLE VELOCITY	655 m/s
WEIGHT	
RGM-2 fuze	0.438 kg
projectile	31.61 kg
driving bands	0.786 kg
charge	5.86 kg
cartridge case	7.5 kg
propellant	8.015 kg
primer sleeve	0.09 kg
total projectile	43.90 kg
total charge	16.36 kg
LENGTH	
fuze	130 mm
projectile	640 mm
cartridge case	545 mm
primer sleeve	30 mm
total projectile	702 mm
total charge	547 mm

122 mm and 152 mm Artillery Jamming Projectiles

Bulgaria has developed 122 mm and 152 mm artillery projectiles carrying R-045 and R-046 jammers which are designed to create barrage jamming in enemy tactical control units operating in the 20 to 100 MHz frequency. They are divided into five sub-bands depending on the length of the transmitter and the battery used.

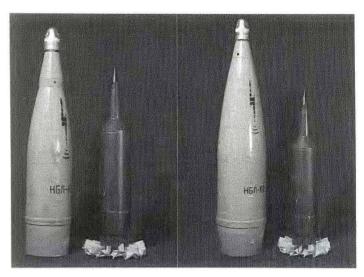
Type	Battery	Length
R-045	electrolyte reservoir	510 mm
R-045L	lithium	510 mm
R-045M	smoke effect	510 mm
R-046L	lithium	415 mm
R-046M	smoke effect	415 mm

In addition, practice projectiles are also available for training purposes and when these are fired they produce a smoke effect on landing.

The R-045 and R-046 do not require any maintenance when in store or when employed and, according to the manufacturer, there are no restrictions as to the type of vehicle carrying the jammer.

SPECIFICATIONS (transmission)

FREQUENCY BAND	20-100 MHz, divided into 5 bands
SUPPLY VOLTAGE	12-16 V
CURRENT CONSUMPTION	1.8 A
OPERATIONAL RANGE	700 m
CONTINUOUS OPERATION	
TIME	1 hr
WEIGHT	3.8 kg
OPERATING TEMPERATURE	
RANGE	-40 to +50°
FIRING RANGE	3.5-14 km



Bulgarian 122 mm (left) and 152 mm (right) artillery jamming projectiles with their payloads to the right

The round types are as follows:

Code	Туре	Propelling Charge	Calibre	Transmitter	Battery
VRS-5L	service	full	122 mm	R-046L	lithium
VRS-5M	dummy	full	122 mm	R-046M	_
VRS-6L	service	reduced	122 mm	R-046L	lithium
VRS-6M	dummy	reduced	122 mm	R-046M	_
VRS-463L	service	adjustable	122 mm	R-046L	lithium
VRS-463M	dummy	adjustable	122 mm	R-046M	-
VRS-546	service	full	152 mm	R-045	electrolyte
					reservoir
VRS-546L	service	full	152 mm	R-045L	lithium
VRS-546M	dummy	full	152 mm	R-045M	-
VRS-546U	service	reduced	152 mm	R-045	electrolyte
					reservoir
VRS-546UL	service	reduced	152 mm	R-045L	lithium
VRS-546UM	dummy	reduced	152 mm	R-045M	_

Status: Production as required.

Manufacturer: State factories. Marketing is carried out by KINTEX, 66 Anton Ivanov Blvd, PO Box 209, Sofia, Bulgaria.
Telephone: 66 23 11/65 11 32 Telex: 22471/23243

CANADA

SNC Industrial Technologies Incorporated

SNC Industrial Technologies Incorporated is the designated Canadian manufacturer for medium and large calibre ammunition, artillery and naval guns, tank guns, infantry mortars and hand-held anti-tank weapons. Its capabilities include design, development, testing and manufacture of complete lines of both live and training munitions. Product improvement and development programmes to upgrade products and to respond to new market requirements are conducted. Areas of expertise include ballistics, aero-mechanics, explosives and propellant charge design and engineering. Existing capacity includes the manufacture of fuzes, initiators, delays, tracers, primers, supplementary and propelling charges, pyrotechnics and main explosive charges as required for the main line of products. Special custom-made explosive charges for experimental purposes are also manufactured. Principle army products manufactured are as follows:

Tank Gun Ammunition (for L7 and M68 Guns)

105 mm TP/FSDS-T C-71

105 mm TPDS/T C-74

105 mm Practice, Squash-head, C109

105 mm Practice, Squash-head, C-72

105 mm Blank C1A4

105 mm APFSDS-T FP105/C-76 (developed together with General Defense Corporation and more recently taken over by Olin Ordnance)

Details of the three training 105 mm tank gun rounds are as follows:

Type DESIGNATION WEIGHT	SH/P C-72	TPDS/T C-74	TP/FSDS-T C-71
cartridge	21.6 kg	16.3 kg	16.3 kg
projectile	11.26 kg	4 kg	4 kg
sub-projectile	n/app	2.11 kg	2.18 kg
propellant	2.9 kg	5.1 kg	5.2 kg
PROPELLANT	M1 FNH	M6 NHP	M6 NHP

APFSDS-T C-76

This consists of the 105 mm APFSDS-T C-76 assembled with a propelling charge system capable of launching the tracered projectile at a high muzzle velocity.

SPECIFICATIONS (C-76)

CALIBRE. 105 mm LENGTH cartridge 927 mm WEIGHT cartridge 18 kg

MATERIAL penetrator tungsten alloy Tracer 33MK1

Propellant NQ/M.044 (M-30 optional) Cartridge case steel (brass optional) Liner Titanium Dioxide electric C18 Primer MUZZLE VELOCITY 1485 m/s with NQ/M

1510 m/s with M-30

DISPERSION within 0.30 mils SD horizontal and

vertical

PERFORMANCE penetration of heavy single target at 60° obliquity, equivalent range in excess of

4000 m. Heavy triple target at 65° obliquity in excess of 6000 m

Artillery Ammunition

105 mm howitzer HE M1 (TNT or Comp B) M1 cartridge with Fuze PD M739

105 mm propelling charge M67

105 mm howitzer, HE (C99) 105 mm howitzer, blank (M395)

105 mm howitzer, smoke C102 (DM15)

105 mm howitzer, illuminating C103 (M314A3)

155 mm howitzer smoke, base ejection (DM45) 155 mm howitzer, illuminating (M485A2)

155 mm howitzer, extended range full-bore

155 mm howitzer HE (TNT or Comp B) M107

155 mm propelling charges M3A1, M4A1, M4A2 and M119A2

For 76 mm Gun:

76 mm HESH L29A5 76 mm SH PRAC L40A1





From left to right: Canadian Arsenals 105 mm C-72 SH/P round, 105 mm C-74 TPDS/T round, 105 mm C-76 APFSDS-T round and 105 mm SH/P C-71 round

Manufacturer: SNC Industrial Technologies Incorporated, 5 Montée des Arsenaux, Le Gardéur, Quebec, Canada J5Z 2P4. Telephone: (514) 581 3080 Fax: (514) 581 0231

CHINA, PEOPLE'S REPUBLIC

Chinese—United States Collaboration

The United States and China have collaborated on a programme known as the Large Caliber Ammunition Modernization Program, or LCAMP. In May 1985 the Chinese Government, through the signature of seven Letters of Request, signalled their intent to purchase technical data packages, plant layout designs and technical assistance from the US Government for the modernisation of their artillery production facilities.

The primary objectives of this first programme will be to modernise fuze, detonator and explosives manufacturing facilities in China. Part of the programme will involve establishing a facility to produce M577A1, MTSQ and M739A1 PD fuzes (less explosive elements) and another facility to produce the explosive elements for these fuzes. The programme was planned to take 30 months at a cost of \$30 million.

On January 30 1987, the fuze and detonator programme contract was awarded to Hamilton Technology Inc, General Defence Corporation, of Lancaster, Pennsylvania. They provided a M739A1 production line consisting of 18 rotary, dial-type, automatic assembly machines plus several hand-

To support LCAMP, a US Project Office has been established at the US Army Production Base Modernization Activity at Dover, New Jersey, funded annually by the Chinese for salaries and travel.

China North Industries Corporation Ammunition

The China North Industries Corporation produces a wide range of ammunition, from small arms ammunition, through mortar and rocket ammunition to various forms of anti-aircraft gun and artillery ammunition.

This ammunition is produced for the anti-aircraft machine guns Types 56 and 77.

Projectile type	API	API-T
LENGTH (overall)	147 mm	147 mm
WEIGHT		
complete	121 g	117 g
projectile	48.2 kg	44 kg
MUZZLE VELOCITY	810 m/s	810 m/s
EFFECTIVE RANGE		
air targets	1600 m	1600 m
ground targets	1500 m	1500 m

This ammunition is used in a number of types of anti-aircraft gun including the four-barrel Type 56, the twin-barrel Type 58 and the single-barrel Types

Projectile type	API	API-T
LENGTH (overall)	156 mm	156 mm
WEIGHT		
complete	182 g	176 g
projectile	63.9 g	59.5 g
MUZZLE VELOCITY	980-995 m/s	995-1015 m/s
EFFECTIVE RANGE		
air targets	2000 m	2000 m
ground targets	1000 m	1000 m

23 mm

This calibre is used for aircraft weapons. The 23 mm Type 1 aircraft automatic gun is mounted in bomber aircraft and is used to fire HEI and HEI-T. The Type 2 aircraft automatic gun can be mounted in bomber or strike aircraft and fires HEI or API. The Type 1 has a muzzle velocity of 680 m/s and the Type 2 has a muzzle velocity of 705 ± 10 m/s. A further gun, the Type 2H fires HEI and API, also at a muzzle velocity of 705 ± 10 m/s.

25 mm

This ammunition is produced for use on the Twin-barrel Naval Gun Type 61 and has twin driving bands. Only one type of round appears to be produced, HEI-T. Details of the round are as follows:

37 mm

37 mm calibre ammunition is used for anti-aircraft guns, namely the Types 55, 65, 74 and P793.

Type	HE-T	AP-T	HE	AP/HE
Length	381.88/384.97 mm	382.49/386.22 mm	386 mm	n/av
Weight of round	1.417 kg	1.444 kg	1.417 kg	1.44 kg
Weight of projectile	0.732 kg	0.758 kg	0.732 kg	0.755 kg
Muzzle velocity Max chamber	866 m/s	880 m/s	866 m/s	868 m/s
pressure	2800 kg/cm ²	2900 kg/cm ²	2800 kg/cm ²	2900 kg/cm ²
Tracer duration	6 s	6 s	nil	6 s
Compatible fuze	ML-1	nil	ML-1	nil

57 mm

This ammunition is used with the Anti-aircraft Gun Type 59 and only one type of round is known to be produced, namely HE-T.

Projectile type LENGTH (overall) WEIGHT	HE-T 532 mm
complete round	6.31 kg
projectile	2.8 kg
charge (aluminised	
RDX)	0.153 kg
MUZZLE VELOCITY	1000 m/s
RANGE	
air targets	8800 m
max	12 000 m
FUZE	Liu-2

85 mm

Only one type of ammunition is known to be produced in this calibre, a HEAT-FS. It is fired from the 85 mm Gun Type 56 and may also be fired from tank guns and some self-propelled guns. Two types of HE-Frag may also be encountered in this calibre, and two earlier fragmentation rounds are no longer produced.

Projectile type	HEAT-FS
LENGTH (overall)	990 mm
WEIGHT	
complete round	12.5 kg
projectile	7 kg
shaped charge	
(TNT/RDX 50:50)	0.647 kg
MUZZLE VELOCITY	845 m/s
RANGE (direct fire)	970 m
PENETRATION	100 mm at 65°
FUZE	Dian-1A

100 mm smooth-bore ammunition

NORINCO manufactures a range of ammunition for its 100 mm smoothbore anti-tank gun Type 86:

Projectile type	Tungsten penetrator APDS Type 86	Tungsten penetrator APDS Type 73	HEAT-FS Type 73	HE-FS Type 73
MUZZLE VELOCITY	1610 m/s	1500 m/s	1010 m/s	900 m/s

100 mm HE round

China produces its own version of the former Soviet 100 mm D-10T tank gun which is fitted to the Type 59 MBT (former Soviet T-54), but the Chinese designation for this gun is not known. This round is understood to have a maximum range of 20 000 m.

Projectile type	HE	
LENGTH (overall)	1.089 m	
WEIGHT		
complete round	30 kg	
projectile	15.6 kg	
charge (TNT)	1.5 kg	
MUZZLE VELOCITY	900 m/s	

APFSDS-T rounds

NORINCO are now producing APFSDS-T rounds for the 100 mm rifled gun installed in the Chinese Type 59 MBT and former Soviet T-54/T-55 MBTs as well as a 105 mm round which can be fired from the US M68 or the British L7 series rifled tank guns fitted in many tanks including some modified Chinese vehicles.

The 100 mm APFSDS-T round has a muzzle velocity of 1480 m/s and will penetrate 150 mm of armour at a slope of 65° at a range of 2400 m. The complete round weighs 15 kg while the projectile itself weighs 5.56 kg. A brass cartridge case is used.

The 105 mm APFSDS-T round has a tungsten alloy penetrator that will penetrate 150 mm of armour at a slope of 60° at a range of 2500 m; it can also penetrate a NATO heavy triple target at the same range. It is believed that this round uses a semi-combustible cartridge case.

SPECIFICATIONS

CALIBRE	105 mm
WEIGHT	
complete round	18.7 kg
projectile	6.15 kg
finned penetrator	4.18 kg
propellant	5.7 kg
LENGTH	
complete round	887 mm
projectile	447 mm
MUZZLE VELOCITY	1455 m/s
MAX CHAMBER	
PRESSURE	4600 kg/cm ²
TRACER BURNING TIME	2.4 s

120 mm Tank Ammunition

Early in 1992, NORINCO announced that it had developed a new 120 mm APFSDS projectile with a semi-combustible cartridge case. All that remains after firing is the stub case.

It is believed that this is not interchangeable with Western 120 mm ammunition fired by the Leopard 2, M1A1/M1A2 and Leclerc MBTs. According to NORINCO, this 120 mm round is fired by a self-propelled antitank oun.

The tungsten alloy fin-stabilised penetrator has a length-to-diameter ratio of 25 to 1 and is claimed to be able to penetrate 550 mm of vertical homogenous armour at a range of 2000 m. Maximum chamber pressure is quoted as $550 \times Pa$.

SPECIFICATIONS

CALIBRE	120 mm
WEIGHT (projectile)	23 kg

125 mm Tank Ammunition

In early 1992, NORINCO announced that it had developed a 125 mm smooth-bore tank gun and its associated APFSDS ammunition, the latter being claimed to be fully interchangeable with that used by the former Soviet T-72 MBT. The new Chinese MBT, the Type 90 – II, is armed with a 125 mm smooth-bore tank gun fed by an automatic loader.

The 125 mm ammunition is of the separate loading type, for example, projectile and charge.

According to NORINCO, the APFSDS round will penetrate 220 mm of homogenous armour at an angle of 61.5° at a range of 2000 m.

SPECIFICATIONS

CALIBRE	125 mm
LENGTH (complete round	
when in breech)	672 mm
LENGTH (projectile)	554 mm
LENGTH (propellant)	407 mm
TOTAL WEIGHT	21.3 kg
WEIGHT (projectile)	7.37 kg
CALIBRE (penetrator)	28 mm
WEIGHT (penetrator)	4.03 kg
ACCURACY (at 1000 m)	$0.3 \times 0.3 \text{ m}$

122 mm

This calibre of ammunition is used with the Howitzer Type 54 and is produced in four types: HE, smoke, illuminating and incendiary, but no information is available regarding the incendiary round. The projectiles are fired using a nine-charge system consisting of a single base charge and two layers of four charge bags. A 122 mm cargo round with six layers of HEAT bomblets has been developed; it is not known whether it has entered production.

Projectile type	HE	Smoke	Illuminating ¹
LENGTH (projectile)	559 mm	551 mm	531 mm
WEIGHT			
complete round	27 kg	28 kg	27.5 kg
projectile	21.76 kg	22.55 kg	21.9 kg
filling	3.5 kg	3.65 kg	1.515 kg
TYPE OF FILLING	TNT	WP	illuminant
MUZZLE VELOCITY	515 m/s	509 m/s	496 m/s



122 mm ammunition, left to right, cargo bomblet, illuminating and HE base bleed

Projectile type RANGE	HE	Smoke	Illuminating ¹
max	11 800 m	11 930 m	11 000 m
min	5350 m	5000 m	2000 m
FUZE	Liu-4	Yan-2	Shi-1

Produces 450 000 candela for 25 seconds with an air burst at over 2000 m

130 mm

NORINCO are now offering no less than 10 projectiles that can be fired from the Chinese NORINCO 130 mm Type 59 and Type 59-1 guns or the original Soviet 130 mm M-46 and details of these, from Chinese sources, are given in the table.

130 mm ERFB-BB

This can be fitted with an electronic proximity fuze.

130 mm smoke

This contains 24 smoke canisters with a maximum burning time of 200 seconds.

130 mm cargo

This contains 35 anti-armour/anti-personnel bomblets which are ejected over the target by the MS-1 time fuze. The bomblets can also be fitted with an electronic proximity fuze.

130 mm shrapnel

Each projectile contains 10 000 flechettes.

130 mm illuminating

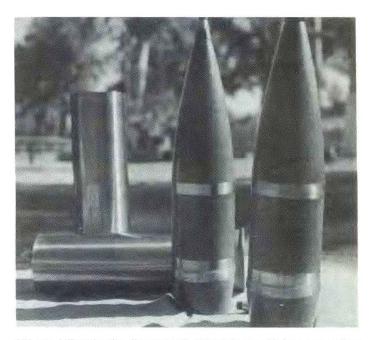
This has a burst height of 900 to 1000 m, burning time is about 40 seconds and drop velocity is 10 m/s with flare having a 50 million candlepower.

130 mm ERFB-B

This does not have a base bleed unit but its shape gives it an extended range when compared to a standard projectile.



Chinese ammunition, from left to right 122 mm HE with fuze, 130 mm HE with fuze and 130 mm HE-BB with fuze



130 mm HE projectiles (foreground) without fuzes with brass propellant cases to rear

130 mm ERFB-A/Nub

This can be used with full charge or various numbers of reduced charges to achieve different ranges. ML-5 fuzes can be set to superquick, short delay or long delay.

Туре	HE	HEI	ERFB/BB	ERFB/boat	ERFB-A tail	ERFB-B	ILL	Shrapnel	Cargo	Smoke
LENGTH complete	637 mm	637 mm	800 mm	774 mm	_	_	_	_	687.4 mm	_
WEIGHT overall	59.1 kg	59.1 kg	59 kg	58.4 kg	58.01 kg	58.4 kg	54.8 kg	_	33 kg	56.8 kg
LENGTH projectile	637 mm	661 mm	_	_	799 mm	774 mm	663 mm	664 mm	_	663 mm
WEIGHT projectile	33.4 kg	33.4 kg	33.4 kg	32.7 kg	32.41 kg	_	20.1 kg	33 kg	_	32.47 kg
MAX RANGE	27.49 km	27.49 km	38 km	30 km	32 km	30.7 km	25 km	25 km	25 km	26 km
MUZZLE VELOCITY	930 m/s	930 m/s	_	940 m/s	944 m/s	940 m/s	952 m/s	_	926 m/s	935 m/s
FUZE	ML-5	ML-5	ML-5	ML-7A	ML-5	ML-7A	MS-1	MS-1	MS-1	MS-1

152 mm

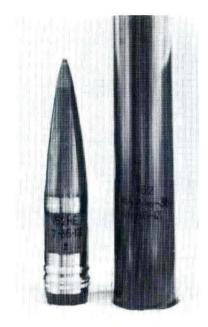
This ammunition is fired from the Chinese 152 mm Gun/Howitzer Type 66 and can also be fired from the former Soviet Gun/Howitzer M1937 (ML-20). It is fired using a full or reduced variable charge from the Type 66, the full variable charge having two zones and the reduced variable charge 5.

Projectile type	HE	Smoke
LENGTH (projectile) WEIGHT	702 mm	689.7 mm
complete round	59.5 kg	59.5 kg
projectile	43.56 kg	43.56 kg
filling	5.86 kg	6.626 kg
TYPE OF FILLING	TNT	WP
MUZZLE VELOCITY	655 m/s	655 m/s
MAX RANGE	17 230 m	17 230 m
FUZE	Liu-4	Yan-2

An HE RAP projectile known as the MP-152 has been added to this range. This is claimed to have the same accuracy and lethality as orthodox projectiles and weighs 43.56 kg when fired. A 27 per cent increase in range is claimed, ie from 17 230 m to 21 880 m.

155 mm

China has developed the 155 mm Type WAC 21 gun/howitzer which was first shown in late 1986. This fires the following types of ERFB ammunition, all of which have welded nubs:



HE projectiles and charge cases for 152 mm Type 66 Gun/Howitzer

Туре	ERFB HE	ERFB HE-BB	ERFB-BB WP smoke	ERFB illuminating	ERFB smoke
LENGTH (projectile)	938 mm	938 mm	938 mm	940 mm	940 mm
WEIGHT (projectile)	45.5 kg	47.9 kg	47.9 kg	45.2 kg	45.7 kg
MUZZLE VELOCITY	897 m/s	903 m/s	795.5 m/s	789.6 m/s	974.5 m/s
MAX RANGE	30 km	39 km	26 km	24 km	26 km
COMPATIBLE FUZE	M739	M739	M739	M557	M557

Notes:

ERFB WP lasts 75 seconds with a width of 30 to 40 m ERFB illuminating, 16 million candlepower for 140 seconds

ERFB smoke, big canister lasts 120 seconds, small canister lasts 65 seconds.



In addition, NORINCO are also developing three new 155 mm projectiles: ERFB-BB illuminating with M577 fuze, maximum range claimed is 30 600 m ERFB-ICM, improved conventional munition with 72 bomblets and M577 fuze, maximum range claimed is 39 600 m

ERFB-ICM-BB, improved conventional munition with 72 bomblets and M577 fuze, maximum range claimed is 39 600 m

Manufacturer: China North Industries Corporation, 7A Yuetan Nanjie, PO Box 2137 Beijing, People's Republic of China.
Telephone: (86) 6898/3461/3471/7570 Telex: 22339 CNIN CN

152 mm HE MP-152 projectile and charge case for Type 66 Gun/Howitzer

CPMIEC RAP-130 130 mm Rocket-Assisted **Projectile**

Development/Description

The China Precision Machinery Import & Export Corporation has developed a 130 mm rocket-assisted projectile for use with the Chinese 130 mm Type 59 and Type 59-1 (equivalent of the former Soviet 130 mm M-46 field gun) artillery systems.

This is designated the RAP-130 and can be fired from the artillery system without any modification.

SPECIFICATIONS

CALIBRE 130 mm MUZZLE VELOCITY 930 m/s PROJECTILE WEIGHT 33.4 kg RANGE INCREASE **ENVIRONMENTAL**

TEMPERATURE RANGE

-40 to +50°C

Status: Development complete. Ready for production.

Manufacturer: China Precision Machinery Import and Export Corporation,

PO Box 845, Beijing, People's Republic of China. Telephone: 895012/8311804 Telex: 22484 CPMC CN

Fax: 8311657

COMMONWEALTH OF INDEPENDENT STATES

Tank Ammunition

Listed below is a résumé of ammunition for the guns installed in T-64/T-72/ T-80 (125 mm), T-62 (115 mm), T-54/T-55 (100 mm), T-34/85 (85 mm) and PT-76 (76 mm) tanks.

125 mm Tank Guns 2A46 (T-72 and T-80) and 2A26

The T-64 tank has the 2A26 smooth-bore gun with a vertical ammunition stowage system whereas the T-72 and T-80 have the 2A46 smooth-bore gun with a horizontal ammunition feed system. Both fire the same separate loading ammunition, eg projectile and charge. Provisional details of these are:

Type	HE-FRAG (FS)	HEAT-FS	APFSDS
DESIGNATION	OF-19	BK-14M	BM-9
FUZE	V-429 PD	PIBD	none
FILLING	TNT	RDX or HMX	none
LENGTH OF			
PROJECTILE	680 mm	680 mm	600 mm
MUZZLE VELOCITY	850 m/s	850 m/s	1800 m/s

115 mm Tank Gun U-5TS for T-62 Series Medium Tanks

Туре	HE-FRAG (FS)	HEAT-FS	HEAT-FS	APFSDS
DESIGNATION	OF-18	BK-4	BK-4M	BM-6
FUZE MODEL	V-429E	GPV-2	GPV-2	n/app
WEIGHT				
complete round	28.1 kg	26.2 kg	26.2 kg	22.5 kg
projectile	17.72 kg	11.79 kg	13.13 kg	5.39 kg
bursting charge	2.72 kg	1.55 kg	1.45 kg	n/app
TYPE OF BURSTING CHARGE	TNT	RDX/aluminium	RDX/wax	n/app
MUZZLE VELOCITY	750 m/s	900 m/s	900 m/s	1680 m/s
ARMOUR PENETRATION AT 0°	n/app	432 mm	440 mm	330 mm

Note: OF-18 is known as the extended range version and replaces the earlier OF-11 which has a muzzle velocity of about 915 m/s.

100 mm Tank Guns D-10T, D-10TG and D-10T2S for T-54 and T-55 Series Medium Tanks

Type PROJECTILE DESIGNATION FUZE MODEL WEIGHT	FRAG-HE OF-412* V-429	APC-T BR-412D** DBR-2	HVAPDS-T BM-8 n/app	HEAT-FS ZBK-5M VP-9	AP-T BR-412 MD-8	HE F-412 RGM
projectile bursting charge TYPE OF BURSTING	15.59 kg 1.46 kg	16 kg 0.064 kg	5.69 kg n/app	12.36 kg 1.038 kg	15.69 kg 0.05 kg	15.84 kg 2.159 kg
CHARGE MUZZLE VELOCITY ARMOUR PENETRATION	TNT 900 m/s	RDX/alu 1000 m/s	n/app 1415 m/s	RDX/wax 900 m/s	RDX/alu n/a	TNT 900 m/s
(at 0° obliquity)	n/app	185 mm/1000 m	200 mm/1000 m	380 mm	150 mm/1000 m	n/app

Other projectiles available. Some cartridges have reduced propelling charges.

85 mm Tank Gun M1944 (ZIS-S-53) for T-34/85 and T-44 Medium Tanks

Type	FRAG	AP-T	HVAP-T	HEAT-FS
PROJECTILE DESIGNATION	O-365K*	BR-365K**	BM-365PK***	BK-2M
FUZE MODEL	KTM-1	MD-8	n/app	n/a
WEIGHT				
projectile	9.6 kg	9.36 kg	5.06 kg	7.34 kg
bursting charge	0.77 kg	0.490 kg	n/app	0.96 kg
TYPE OF BURSTING CHARGE	TNT	RDX/alum	n/app	RDX/wax
MUZZLE VELOCITY	792 m/s	800 m/s	1030 m/s	840 m/s
ARMOUR PENETRATION				
(at 0° obliquity)	n/app	102 mm/1000 m	130 mm/1000 m	n/a

^{*} Other projectiles available. Some cartridges have reduced propellant charges

^{**} Older design projectiles BR-412 and BR-412B are also used with rounds giving penetrations of 135 mm and 150 mm respectively.

^{**} Other projectiles available.

^{***} Spool type, possibly replaced by improved model.

76 mm Tank Guns D-56T and D-56TM for PT-76 Series Amphibious Tanks

Type PROJECTILE DESIGNATION FUZE MODEL WEIGHT	FRAG-HE	AP-T	HVAP-T	HEAT	API-T
	OF-350*	BR-350*	BM-354P**	BK-350M***	BZR-350B
	KTM-1	MD-5	n/app	BM	MD-5
projectile bursting charge TYPE OF BURSTING	6.2 kg 0.712 kg	6.5 kg 0.15 kg	2.98 kg n/app	3.94 kg 0.51 kg	6.48 kg 0.11 kg
CHARGE MUZZLE VELOCITY ARMOUR PENETRATION	TNT	TNT	n/app	RDX/TNT	TNT
	680 m/s	655 m/s	950 m/s	325 m/s	655 m/s
(at 0° obliquity)	n/app	61 mm/1000 m	58 mm/1000 m	120 mm	61 mm/1000 m

^{*} A number of other projectiles are also available, some with cartridges with reduced propellant charges.

Artillery Ammunition

Listed below is a résumé of some of the ammunition fired by the former Soviet Union's towed and self-propelled artillery systems.

180 mm Gun S-23

FRAG-HE projectile OF-43 weighing 84.09 kg with a maximum muzzle velocity of 790 m/s, HE/RAP with a maximum muzzle velocity of 850 m/s, concrete piecing G-572 projectile weighing 97.7 kg and a 0.2 kt tactical nuclear projectile.

152 mm Krasnopol Guided Projectile

The former Soviet Union developed a 152 mm laser designated artillery projectile that is similar in concept to the US Martin Marietta 155 mm Copperhead Cannon Launched Guided Projectile (CLGP) that was used in small numbers during the 1991 Middle East conflict.

The 152 mm laser designated projectile is called the Krasnopol and is known to be fired from the older 152 mm 2S3M Self-Propelled (SP) artillery system as well as the towed 152 mm D-20 system. It may be able to be fired from the more recent 152 mm 2S5 and 2S19 SP artillery systems although these have a more recent projectile and charge system.

Until the introduction of the 152 mm Krasnopol projectile, artillery systems had little capability of engaging mobile or hard targets in the indirect fire mode.

Once a target, typically a Main Battle Tank (MBT), has been detected by the forward observer, target information co-ordinates are conveyed to the battery command post. If the target is within range, the firing calculations (for example, elevation, traverse and charge) are passed to the gun which is then loaded and laid onto the target using normal artillery drills, while the forward observer is alerted. The gun is then fired and, as the projectile nears the target, the forward observer illuminates the target using tripod mounted locator designator. The key to a successful engagement is the synchronisation of information between the weapon and the forward observer.

The seeker mounted in the nose of the 152 mm Krasnopol projectile locks onto the illuminated target and, shortly before impact, the projectile makes a top attack on the vulnerable upper surfaces of the MBT, typically at an angle of between +35 and +45°. The seeker mounted in the nose of



152 mm Krasnopol semi-active laser homing guided projectile (Christopher F Foss)

the 152 mm Krasnopol projectile has a footprint of about 1000 m. The projectile is controlled/steered by four canards that are located on the midsection of the projectile and stabilised by four fins at the rear. When fired to its maximum range of 18 km, the 152 mm Krasnopol projectile is claimed to have an 0.7 hit probability against stationary and moving targets.

To prove the operational concept of the 152 mm Krasnopol system, extensive trials were carried out under a wide range of operational conditions. During one trial, the first 152 mm Krasnopol projectile hit a target travelling at a speed of 38 km/h at a range of 14 km. While in another target three different targets were engaged 30 seconds apart using a single locator designator.

Although the primary role of the Krasnopol 152 mm projectile is anti-tank, it can also be used against other high value targets such as artillery and air defence weapons, as well as heavily fortified positions. During one trial, three weapons each fired a 152 mm Krasnopol projectile at the same time, at a fortified target which was being designated by a single locator designator. It has been evaluated under hot and cold conditions and at an altitude of 2500 m/s and in wind speeds of up to 25 m/s a second. It has also been demonstrated that the 152 mm Krasnopol projectile can hit a moving ship so giving the weapon a useful coastal defence capability.

It is claimed that the development of the 152 mm Krasnopol projectile gives a 40 to 50 times reduction in artillery expenditure to kill point targets (with the obvious logistical advantages) and a three to five time reduction in the time taken to engage point targets.

SPECIFICATIONS

CALIBRE	152 mm
RANGE (D-20 and 2S3)	3-20 km
GUIDANCE	
middle part of trajectory	inertial
TERMINAL	laser semi-active homing
WEIGHT (projectile)	50 kg
WEIGHT (warhead)	20.5 kg
WARHEAD TYPE	HE-F

152 mm Gun 2A36 (M1976), 152 mm Self-propelled Gun 2S5

Fires separate loading ammunition (projectile and charge) including HE-FRAG, AP-T, smoke, illuminating, chemical, concrete piercing, incendiary and tactical nuclear.

152 mm Gun-Howitzer D-20, 152 mm Self-propelled Gun Howitzer M-1973 (2S3)

Ammunition type PROJECTILE DESIGNATION FUZE MODEL WEIGHT	FRAG-HE OF-540* RGM-2	CP G-545** KTD	AP-T BR-540 MD-7
projectile bursting charge TYPE OF BURSTING	43.51 kg 6.25 kg	56 kg 4.22 kg	48.78 kg 1.2 kg
CHARGE MUZZLE VELOCITY ARMOUR PENETRATION	TNT 655 m/s	TNT 670 m/s	n/app 600 m/s
AT 0°	n/app	n/app	124 mm/1000 m

Other FRAG-HE projectiles also available.

Other types of ammunition include chemical, high explosive rocket-assisted projectile, HEAT, illuminating (S-540), smoke (D-540), tactical nuclear (0.2 kt), HEAT-SS (spin-stabilised), flechette, scatterable mines (anti-tank and anti-personnel).

^{**} Spool type, possibly replaced by improved model.

^{***} World War II model, possibly replaced by improved type.

^{**} Other CP projectiles available.

152 mm Howitzer M1943 (D-1)

Ammunition type PROJECTILE DESIGNATION WEIGHT	FRAG-HE OF-530	FRAG-HE OF-530A	CP G-530
projectile	40 kg	40 kg	40 kg
bursting charge TYPE OF BURSTING	6.86 kg	5.66 kg	5.1 kg
CHARGE	TNT	TNT	TNT
MUZZLE VELOCITY	508 m/s	508 m/s	508 m/s

Other types of projectiles include chemical, heat, illuminating and smoke.

130 mm Field Gun M-46

Ammunition type PROJECTILE DESIGNATION FUZE MODEL WEIGHT	FRAG-HE OF-482M RGM-2	APC-T BR-482B DBR
projectile	33.4 kg	33.6 kg
bursting charge	4.63 kg	0.127 kg
TYPE OF BURSTING		
CHARGE	TNT	RDX/alum
MUZZLE VELOCITY	930 m/s	930 m/s
ARMOUR PENETRATION		
AT 0°	n/app	230 mm/1000 m

Other types of projectile include SP-46 illuminating, smoke, target marking, chemical and rocket-assisted projectile.

122 mm 2S1 Self-propelled Gun, 122 mm Howitzer D-30

Ammunition type	FRAG-HE	HEAT-FS
PROJECTILE DESIGNATION	OF-462*	BK-6M**
FUZE MODEL	RGM-2	GPV-2
WEIGHT		
projectile	21.76 kg	21.63 kg
bursting charge	3.675 kg	n/a
TYPE OF BURSTING		
CHARGE	TNT	RDX
MUZZLE VELOCITY	690 m/s	740 m/s
ARMOUR PENETRATION		
AT 0°	n/a	460 mm/any rang

Other types of projectile include chemical, illuminating (S-462 weighing 22.4 kg), smoke (D-462 weighing 22.3 kg), leaflet, flechette and incendiary. More recently an RAP has been introduced with a maximum range of

122 mm Howitzer M1938 (M-30)

Ammunition type	FRAG-HE	HEAT
PROJECTILE DESIGNATION	OF-462*	BP-463**
FUZE MODEL	RGM-2	n/a
WEIGHT		
projectile	21.76 kg	13.3 kg
bursting charge	3.675 kg	n/a
TYPE OF BURSTING		
CHARGE	TNT	n/a
MUZZLE VELOCITY	515 m/s	570 m/s
ARMOUR PENETRATION		
AT 0°	n/a	200 mm/1000 m

^{*} Other FRAG and FRAG-HE projectiles are available.

Other projectiles include chemical, illuminating (S-462), smoke (D-462) and leaflet (A-462).

122 mm Field Gun D-74

Ammunition type	FRAG-HE	APC-T
PROJECTILE DESIGNATION	OF-472	BR-472
FUZE MODEL	V-429	DBR
WEIGHT		
projectile	27.3 kg	25 kg
bursting charge	2.95 kg	0.091 kg
TYPE OF BURSTING		
CHARGE	TNT	RDX/alum
MUZZLE VELOCITY	885 m/s	885 m/s
ARMOUR PENETRATION		
AT 0°	n/app	185 mm/1000 m

Other types include chemical, illuminating and smoke.

100 mm Field Gun M1944 (BS-3)

Ammunition type	FRAG-HE	APC-T	HVAPDS-T	HEAT-FS
PROJECTILE DESIGNATION	OF-214*	**	BM-8†	ZBK-5M†
FUZE MODEL	V-429	DBR-2	n/app	VP-9
WEIGHT				
projectile	15.59 kg	16 kg	5.69 kg	12.36 kg
bursting charge	1.46 kg	0.064 kg	n/app	1.038 kg
TYPE OF BURSTING CHARGE	TNT	RDX/alum	n/app	RDX/wax
MUZZLE VELOCITY	900 m/s	1000 m/s	1415 m/s	900 m/s
ARMOUR PENETRATION AT 0°	n/app	185 mm/1000 m	200 mm+/1000 m	380 mm/any range

^{*} Other projectiles available, some cartridges have reduced propelling charges.

85 mm Auxiliary-propelled Field Gun SD-44, 85 mm Divisional Gun D-44

Ammunition type	FRAG-HE	AP-T	HVAP-T	HEAT-FS
PROJECTILE DESIGNATION	O-365K*	BR-365**	BR-365P†	BK-2M‡
FUZE MODEL	KTM-1	MD-5	n/a	n/a
WEIGHT				
projectile	9.6 kg	9.2 kg	5.06 kg	7.34 kg
bursting charge	0.77 kg	0.068 kg	n/a	0.96 kg
TYPE OF BURSTING CHARGE	TNT	RDX/alum	n/a	RDX/wax
MUZZLE VELOCITY	792 m/s	792 m/s	1030 m/s	840 m/s
ARMOUR PENETRATION AT 0°	n/app	125 mm/1000 m	180 mm/1000 m	300 mm/any range

^{*} Other projectiles available, some cartridges have reduced charges.

^{*} There are variants of projectile design giving different weights. Various other fuzes may also be used.

^{**} Rotating BP-463 may also be used.

^{**} Fired at full charge. Better design than earlier BP-460A.

^{**} Older design projectiles BR-412 and BR-412B also used with rounds giving penetrations of 135 mm and 150 mm respectively.

[†] Employment with this weapon not confirmed; normally used by D-10 tank gun in T-54/T-55.

^{**} Other projectiles available.

[†] Spool type, possibly replaced by improved model.

[‡] Employment with 85 mm field guns not confirmed.

Cannon Ammunition

23 mm Ammunition

This is fired from the 23 mm cannon installed in the ZU-23-2 towed anti-aircraft gun system and the ZSU-23-4 self-propelled anti-aircraft gun system.

TYPE	HEI-T
CALIBRE	23 mm
WEIGHT (cartridge)	435 g
LENGTH (cartridge)	236 mm
WEIGHT (propellant)	78 g
WEIGHT (projectile)	183 g
EXPLOSIVE CONTENT	0.0179 g
MUZZLE VELOCITY	970-990 m/s

Note: Other 23 mm ammunition types for the ZU-23 and ZSU-23-4 air defence weapons include the API-T (BZT) which has a similar muzzle velocity to the above and will penetrate 25 mm of armour at a range of 500 m or 19.3 mm of armour at a range of 1000 m, inert training and blank.

30 mm Ammunition

This fixed ammunition is fired by the following weapons: 30 mm 2A42 cannon installed in BMP-2 infantry fighting vehicle 30 mm 2A72 cannon installed in BMP-3 infantry fighting vehicle 30 mm 2A38 cannon installed in 2S6 Tunguska self-propelled anti-aircraft gun/surface-to-air missile system.

TYPE	AP-T	HE-I
CALIBRE	30 mm	30 mm
WEIGHT (cartridge)	853 g	837 g
LENGTH (cartridge)	291 mm	291 mm
WEIGHT (propellant)	127 g	123 g
WEIGHT (projectile)	400 g	389 g
MUZZLE VELOCITY	960/980 m/s	950/970 m/s
TRACER BURN TIME	not less than 3.5	S

EGYPT

Heliopolis Company Ammunition

The Heliopolis Company for Chemical Industries began production in 1949 and now produces ranges of tank and artillery ammunition, mortar bombs, artillery rockets and aircraft bombs. Production also includes the manufacture of various types of explosive (including hexogen and nitropenta), smoke generators, pyrotechnics and various NBC defence products. The range of tank gun and artillery ammunition currently manufactured is as follows:

57 mm

Three types of ammunition are manufactured in this calibre, an HE-T (FRAG-T) for the former Soviet S-60 anti-aircraft gun and two types of ammunition (HE and AP) for the former Soviet 57 mm M1943 (ZIS-2) anti-tank gun. Details of these rounds are as follows:

Projectile type LENGTH (complete round) WEIGHT	HE-T 529.92 mm	AP 675.95 mm	HE 672.92 mm
complete round	6.309 kg	7 kg	_
projectile	3.309 kg	3.176 kg	3.75 kg
propellant	1.19 kg	1.45 kg	0.895 kg
filler	0.153 kg	0.118 kg	0.192 kg
TYPE OF FILLER	Hexal	Hexogen	TNT
MUZZLE VELOCITY	1000 m/s	990 m/s	706 m/s
MAX RANGE	12 000 m	2000 m	8000 m
TYPE OF FUZE	MG-57	MD-10	KTM-1

85 mm

Three types of ammunition are manufactured in 85 mm calibre for three different weapons. One HE (FRAG) round is produced for the 85 mm M1944 (PLK-44) anti-aircraft gun. An AP round is produced for use in tank guns such as the T-34/85 (gun TK-44) while an HE round is produced for artillery weapons such as the 85 mm Divisional Gun D-44 (ATM 44/38/52). Details of these rounds are as follows:

Projectile type LENGTH (complete round) WEIGHT	HE(FRAG) 965.38 mm	AP 922.97 mm	HE n/a
complete round	16.1 kg	16.1 kg	16.1 kg
projectile	9.2 kg	9.155 kg	9.54 kg
propellant	2.8 kg	2.85 kg	0.78 kg
filler	0.66 kg	0.55 kg	0.78 kg
TYPE OF FILLER	TNT	Hexogen	TNT
MUZZLE VELOCITY	885 m/s	800 m/s	785 m/s
MAX RANGE	18 000 m	direct fire	15 800 m
TYPE OF FUZE	EMCZC 30	MD-8	KTM-1

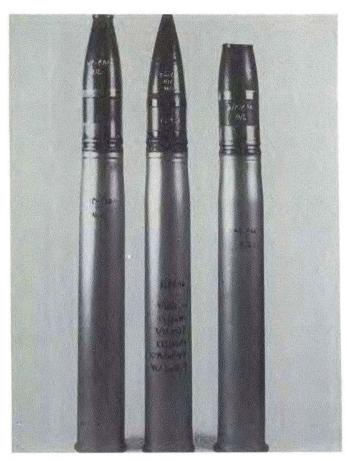


From left to right: HE for 57 mm M1943 anti-tank gun, HE-T for S-60 antiaircraft gun, AP for 57 mm M1943 anti-tank gun

100 mm

Four rounds are produced, two types of HE (one for use with the KS-19 anti-aircraft gun), AP and AP-Prac. These rounds are interchangeable between a wide range of weapons such as the former Soviet M1944 (BS-3) field gun and the D-10 tank gun series fitted to T-54/55 MBTs. Details of these rounds are given below:

Projectile type LENGTH (complete round) WEIGHT	HE(FRAG) 1124.36 mm	APHE 922.97 mm	AP PRAC 922.97 mm	HE 1092.09 mm	
complete round	30 kg	29.6 kg	29.6 kg	30 kg	
projectile	15.6 kg	14.74 kg	14.74 kg	15.6 kg	
propellant	5.6 kg	5.72 kg	5.72 kg	5.6 kg	
filler	1.62 kg	0.054 kg	0.054 kg	1.606 kg	
TYPE OF FILLER	TNT	Hexal	inert	TNT	
MUZZLE VELOCITY	900 m/s	925 m/s	925 m/s	900 m/s	
MAX RANGE	16 000 m	3000 m direct	17 000 m	19 800 m	



From left to right: 85 mm HE(FRAG) for M1944 anti-aircraft gun, 85 mm AP, 85 mm HE (unfuzed)

105 mm

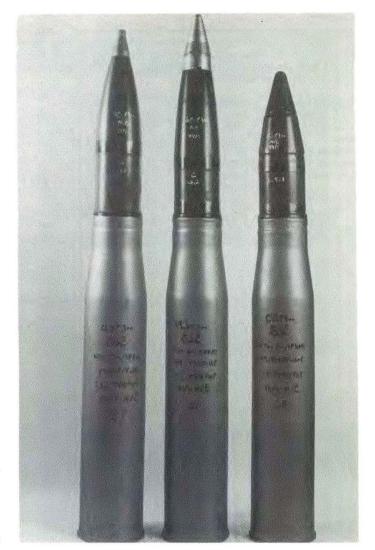
Ammunition produced in 105 mm calibre consists of American ammunition produced under licence for use in the M68 tank guns fitted to the M60A3 tanks of the Egyptian Army. Currently in production are M735 APFSDS-T, M274 TPDS-T, M456A1 HEAT-T and M490 TP-T ammunition. The specifications given below are from Egyptian sources:

Projectile type DESIGNATION LENGTH	APFSDS-T M735	TPDS-T M724	HEAT-T M456A1	TP-T M490
(complete round) WEIGHT	963.67 mm	838.2 mm	1219.2 mm	1143 mm
(complete round) TYPE OF HE	17.237 kg	14.51 kg —	21.77 kg Comp B	20.4 kg
WEIGHT OF HE TYPE OF	_	_	0.97 kg	_
PROPELLANT	M30	M1	M30	M30
MUZZLE VELOCITY MAX RANGE FUZE	1508 m/s 2000 m	1508 m/s 2000 m	1178 m/s 8200 m PI BD-509A	1170 m/s 8200 m

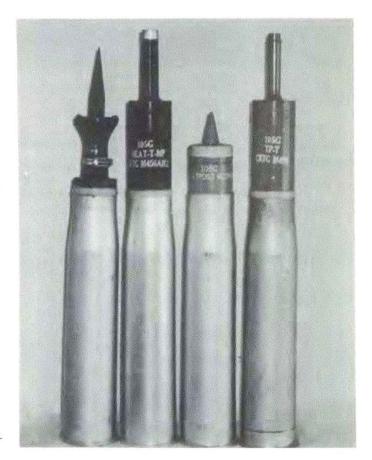
More recently two additional rounds have been placed in production for the 105 mm M68 tank gun. $\,$

SP	EC	IF	CA	TIC	ONS

SPECIFICATIONS		
Туре	HE	Training
WEIGHT		
projectile	14.85 kg	14.85 kg
propellant	3.23 kg	3.23 kg
HE content	2.15 kg	2.15 kg
TYPE of HE	TNT	inert
WEIGHT		
(complete round)	24.4 kg	24.5 kg
MUZZLE VELOCITY	683 m/s	683 m/s
MAX RANGE	12 500 m	12 500 m
WEIGHT		
(complete round)	24.5 kg	24.5 kg
FUZE	AU-18	dummy



From left to right: 100 mm HE, 100 mm HE for KS-19 anti-aircraft gun, 100 mm AP



From left to right: 105 mm M735 APFSDS-T, M456A1 HEAT-T, M724 TPDS-T, M490 TP-T

115 mm

Two types of ammunition are produced in 115 mm calibre, both for use with the 115 mm U-5TS (2A20) tank gun, referred to in Egyptian references as the Y5TC-T62. The types involved are an HE-FRAG(FS) and an APFSDS, but the data provided in Egyptian references differ from that provided elsewhere and is provided below:

Projectile type LENGTH (complete	HE-FRAG(FS)	APFSDS
round) WEIGHT	1064.5 mm	n/av
complete round	32.17 kg	n/av
projectile	17.535 kg	3.9 kg
propellant	4.5 kg	8.1 kg
HE	2.788 kg	_
TYPE OF HE	TNT	_
MUZZLE VELOCITY	800 m/s	1615 m/s
MAX RANGE	12 000 m	12 230 m
TYPE OF FUZE	AU-20 E	none



Left, complete round and projectile for 115 mm APFSDS; right, complete round and projectile for 115 mm HE-FRAG(FS)

122 mm

122 mm ammunition is produced for two weapons. One is the 122 mm Howitzer M1938 (M-30) and the other the 122 mm Howitzer D-30. Specifications are provided separately for these two types of ammunition.

122 mm Howitzer M1938 (M-30)

Projectile type	HE	ILL
WEIGHT complete round	26.344 kg	29.804 kg
projectile	21.76 kg	21.76 kg
propellant	2.05 kg	2.05 kg
filler	3.5 kg	1.17 kg
TYPE OF FILLER	TNT	illuminant
MUZZLE VELOCITY	515 m/s	515 m/s
MAX RANGE	11 800 m	11 800 m
TYPE OF FUZE	AU-18	T-7

Left, 122 mm HE projectile and case for the D-30 Howitzer; right, case and HE projectile for 122 mm Howitzer M1938. Note that the projectiles are not fitted with a fuze

122 mm Howitzer D-30

Projectile type WEIGHT	HE full	HE reduced	Smoke
complete round	29.564 kg	27.252 kg	27.76 kg
projectile	21.76 kg	21.76 kg	21.76 kg
propellant	3.8 kg	2.365 kg	2.365 kg
TYPE OF FILLER	TNT	TNT	WP
MUZZLE VELOCITY	690 m/s	565 m/s	565 m/s
MAX RANGE	12 000 m	10 000 m	15 300 m
TYPE OF FUZE	AU-18	AU-18	AU-18

130 mm

Three types of ammunition are produced for the 130 mm Field Gun M-46, two HE and one Smoke. Details are as follows:



Projectile type	HE full	HE reduced	Smoke
LENGTH (complete round)	661.65 mm	661.65 mm	661.65 mm
WEIGHT			
complete round	58.7 kg	51 kg	n/a
projectile	33.4 kg	33.6 kg	33.4 kg
propellant	12.9 kg	10.13 kg	n/a
filler	3.5 kg	3.5 kg	3.35 kg
TYPE OF FILLER	TNT	TNT	WP
MUZZLE VELOCITY	930 m/s	507 m/s	n/a
MAX RANGE	27 500 m	19 200 m	n/a
TYPE OF FUZE	AU-18	AU-18	AU-18

Manufacturer: Heliopolis Company for Chemical Industries, Haikstep, Heliopolis, Egypt.

Telephone: (2) 66 53 14/(2) 66 56 28 Telex: 92 708

Maasara Ammunition

The El-Maasara Company was founded in 1952 in Maasara Helwan and today produces medium calibre ammunition from 20 to 40 mm as well as mines, explosives, fuzes, primers and detonators. The following types of ammunition are manufactured:

20 mm HEI and HE-IT for Hispano-Suiza and Oerlikon-Contraves guns

23 mm training ammunition (subcalibre)

23 mm HE-IT for aircraft guns 30 mm DEFA for aircraft guns 30 mm AR-30 for aircraft guns

37 mm HE-IT for anti-aircraft guns

40 mm HE-IT for Bofors 40 mm L/60 anti-aircraft guns

Status: Production as required for Egyptian armed forces and for export.

Manufacturer: Maasara Company for Engineering, PO Box Maasara,

Cairo, Egypt.

Telephone: 3500301 Telex: 92167 LOTFI UN Att HEGROFA

FINLAND

Hackman Cartridge Cases

This company manufactures a wide range of cartridge cases for the home and export market and these include:

Anti-aircraft

40 mm L/60

40 mm L/70

57 mm

Field Artillery

76 mm

122 mm 130 mm

152 mm

Special weapons

100 mm

105 mm

120 mm 122 mm

152 mm

Status: Production as required.

Manufacturer: OY Hackman AB, Quussillantie 18, SF-01230 Vantaa,

Telephone: (358) 0 876 5033 Telex: 122036 kolte sf Fax: (358) 0 876 8875

SAKO Ammunition

SAKO Limited, previously Sako-Valmet, is a major supplier of ammunition and its components to the Finnish defence forces. The company can provide a complete range of ammunition to meet all military requirements for both training and operational ammunition that is manufactured to AQAP requirements

The current product range of ammunition includes:

Calibre	Туре	Application
23 mm × 152 B	TP-T, HEI-T, APHC-T	for ZU-23 and ZSU-23-4 AAG
30 mm × 113 B	TP, TP-T, HEI, HEI-SD, HEI-T, SAPHEI, APHC	for Aden cannon
30 mm × 170 B	TP, TP-T, HEI, HEI-T	for HS-831-L Oerlikon KCB and RARDEN cannon
35 mm × 228	TP, TP-T, TPT-SR, HEI, HEI-T	for Oerlikon AA weapons
40 mm × 311R	TP-T, HEI-T, AP-T	for Bofors L/60 AA weapons
40 mm × 365R	TP, TP-T, HE-T, HEI-T	for Bofors L/70 AA weapons
57 mm × 438	TP	for Bofors L/70 (naval)
81 and 120 mm	HE	mortar bombs
76 mm	HE	for M-48 FH and PT-76 light tank
100 mm	HE	for D-10T tank gun
122 mm	HE	for D-30 FH
130 mm	HE	for M-46 field gun

In addition, the company can provide components such as fuzes and projectiles, as well as brass and steel cartridge cases in calibres from 23 mm to 152 mm.



Some types of ammunition produced by SAKO

Status: Production as required.

Manufacturer: SAKO Limited, Tourula Works, PO Box 60, SF-40101

Jyväskyla, Finland.

Telephone: (358) 41 693211 Fax: (358) 41 693212

Vammas Gun Systems

In January 1991 the activities of Tampella Defence Division and Vammaskoski Works were merged to make a stronger and more competitive coalition on defence products. This new company is called Vammas Limited. It builds on a long experience in the development and production of weapon systems.

The main products of the defence branch are howitzers, mortars and projectile shell bodies. Vammas manufactures projectile shell bodies in 105 mm, 122 mm, 130 mm, 152 mm and 155 mm artillery calibres and mortar shells in 81 mm and 120 mm calibres. In 155 mm howitzer and mortar calibres the complete round, including projectile and charge system, is supplied.

Manufacturer: Vammas Limited, PO Box 18, SF-38201 Vammala, Finland. Telephone: (358) 32 1971 Telex: 22283 Fax: (358) 32 41148



Some of extensive range of artillery and mortar shell bodies produced by Vammas Limited

FRANCE

SNPE Combustible Cartridge Cases

Combustible cartridge cases for howitzers offer the same combustion advantages as conventional bagged charges combined with the mechanical strength requirements called for in automatic loading systems. With the advent of the Giat Industries 155 mm GCT self-propelled artillery system in prospect, the Research Centre of the Société Nationale des Poudres et Explosifs (SNPE), together with Giat Industries, developed a combustible case. SNPE began development of combustible cases in 1970 and, since 1978, a manufacturing facility for the materials involved has been in operation at Bergerac near Bordeaux



155 mm SNPE combustible cartridge cases

The material used for the SNPE combustible cases comes in two forms. Both use the same basic process which involves the mixing of an aqueous slurry containing 65 per cent nitrocellulose, 25 per cent kraft, nine per cent acrylic resin and the remaining one per cent diphenylamine, a stabiliser. In what is known as the felt moulding process the slurry is mixed with water and poured into a shaped mandrel where the water is evacuated under heat and pressure. This process continues with drying and curing under more pressure after which the resultant components are trimmed and finished. This produces components of high mechanical strength that are thinner to aid combustion.

To date, these cases have been fired from the 155 mm Au F1 ordnance used on the GCT. The ordnance involved has a serrated internal breechblock face to break up the base of the combustible case to assist overall combustion. Current development is towards a system of employing telescopic charge elements that can be built up to provide a fully variable charge system. Only the large Charge 8 would have a complete one-piece case. Developments are also under way to provide combustible cases for other calibres. Troop trials with the 155 mm cases have been completed and they have now been accepted for full French Army service.

Since 1990, SNPE has added the post-impregnated process to its range of combustible cartridge cases through its new subsidiary PB Clermont, located near Liege in Belgium. These types of cases had been developed from the late 1960s and mass production commenced in the late 1970s. They were designed for use with the Rheinmetall 120 mm smooth-bore gun installed in the Leopard 2 MBT. PB Clermont is now developing combustible cartridge cases for 155 mm modular charges for use with artillery systems

Late in 1989 the United States Army Test and Evaluation Command (TECOM) successfully completed the safety certification tests of an improved combustible case for the M203A1 propelling charge used with the 155 mm M198 towed artillery system.

This new combustible case is manufactured from a new process that is not based on the common felting technique. For the three components, spiral wrapped body, forward cap, rear cap, it uses a combustible paper which is processed using the various possibilities of paper and cardboard technologies.

Status: Production. In service with France, Iraq and Saudi Arabia. SNPE is also manufacturing the combustible cartridge cases for the 120 mm ammunition used by Leclerc MBT. Production from PB Clermont is in service in various parts of the world.

Manufacturer: SNPE - Société Nationale des Poudres et Explosifs, 12 quai Henri-IV, F-75181 Paris, France.

Telephone: (1) 48 04 66 66 Telex: 240 881 F Fax: (1) 48 04 66 14

PB Clermont, 176 rue de Clermont, B-4480 Engis, Belgium. Telephone: 32 41 75 10 15 Fax: 32 41 75 47 48

Giat Industries Ammunition

In recent years Giat Industries has taken over the product ranges of a number of other manufacturers of ammunition, including FN and PRB of Belgium and Luchaire and Manurhin of France.

155 mm M107 HE Projectile

This is the standard 155 mm M107 projectile and can be fired by virtually all 155 mm artillery systems. Brief specifications are: weight with fuze 43 kg; length with fuze 702 mm; and weight of TNT content 6.6 kg.

155 mm M110 Smoke Projectile

This is the standard 155 mm M110 WP smoke projectile and can be fired by virtually all 155 mm artillery systems. Brief specifications are: weight with fuze 43.6 kg; length with fuze 702 mm; and weight of smoke content is 7.1 kg.

155 mm M485A2 Illuminating Projectile

This is the standard 155 mm M485A2 illuminating projectile and has a light intensity of 1 million candelas which lasts for 120 seconds. Brief specifications are: weight with fuze 42.6 kg; length with fuze 700 mm; and weight of illuminant 2.7 kg.

155 mm DTC Round (OE 155 DTC)

This 155 mm projectile can be used in all 155 mm artillery systems and, when fired by the AU F1, has a maximum range of 28 500 m. Brief specifications are: weight with fuze 43.5 kg; length with fuze 920 mm; and weight of explosive 8.7 kg (TNT/RDX).

Part of the Giat Industries range of 155 mm ammunition with combustile cartridge cases on the right



155 mm Improved Projectiles

These were originally developed by Luchaire in two versions, the 155 LU 111 HB (hollow base) and the 155 LU 111 BB (base bleed). These are modular 155 mm projectiles and, as their bases are detachable in field conditions, it is possible to change from the HB to the BB configuration and vice versa. The projectiles have standard 2 inch fuze wells.

	155 LU 111	BB	155 LU 111	BB
TYPE (explosive)	HT 50/50	T	HT 50/50	T
WEIGHT (charge) WEIGHT (projectile	8.80 kg	8.21 kg	8.80 kg	8.21 kg
with fuze)	43.20 kg	42.60 kg	44.28 kg	43.63 kg
		Maximu	m range	
PROJECTILE (with				
four bags)	155 AU F1	M109A2	M198	FH-70
155 LU 111 HB	23 330 m	19 700 m	23 590 m	23 590 m

155 mm Improved Smoke Projectiles

These are the smoke equivalents of the above and are also available in hollow base or base bleed configurations which can be changed under field conditions

TYPE (charge)	155 LU 114 HB white phosphorous	155 LU 114 BB white phosphorous
WEIGHT (content) WEIGHT (projectile	8.70 kg	8.70 kg
with fuze)	43.15 kg	43.15 kg
	Maximu	m range

PROJECTILE (with				
four bags)	155 AU F1	M109A2	M198	FH-70
155 LU 114 HB	23 330 m	19 700 m	23 590 m	23 590 m
155 LU 114 BB	28 000 m	24 000 m	29 150 m	20 150 m

155 mm Type LU 112 HB Practice Projectile

This is used for training purposes and can be used with all charges. It is supplied with a skirt forming a hollow base which can be replaced by a base bleed unit under field conditions. Brief specifications are: weight with fuze 43.3 kg; length with fuze 865 mm; and weight of explosive content 1 kg

155 mm Hollow Base Projectile Family

These can be fired by all 155 mm NATO standard systems and is also fired by the Giat Industries 155 AU F1 self-propelled artillery system with charge being contained in a combustible cartridge case.

Туре	HE	Smoke	Practice
French Army			
designation	OE 155 F1	OFUM PH 155 F2	OX 155 F1
WEIGHT	43.25 kg	43.15 kg	43.25 kg
WEIGHT (content)	8.83 kg	8.7 kg	1.2 kg

Note: When fired from 155 mm AU F1 has a maximum muzzle velocity of 810 m/s and a maximum range of 23 300 m. Effective pattern of the HE projectile is claimed to be better than 50 per cent of the older US 155 mm M107.

155 mm Smoke Type HC BE ERFB BT NR 268 projectile

This high capacity, base ejection, extended range full-bore smoke projectile with a boat tail was originally developed by PRB and has a maximum range, using M185 charge, of 20 000 m. Brief specifications are: weight with fuze 46 kg; length with fuze 940 mm; with contents being five smoke canisters which provide sufficient smoke for 120 seconds.

155 mm Cargo Type ERFB Base Bleed NR 269

This 155 mm extended range full-bore base bleed cargo round was originally developed by PRB and carries 56 M46 bomblets. Basic specifications are weight with fuze 46 kg and length with fuze 960 mm. Maximum range fired from a GC 45 and GH N45 is 38 000 m and from the M198/M71 is 30 000 m.

155 mm HE Type ERFB BB BR 265

This extended range full-bore base bleed projectile was originally developed by PRB. Basic specifications are: weight with fuze 48 kg; length with fuze 940 mm; and weight of TNT content is 8 kg. Maximum range when fired from the GC 45, GH N45, G5 and G6 is 38 000 m, while range fired from a M71/FH-70 and M114/39 is 30 000 m.

155 mm HE Type ERFB BT NR 173 Round

This HE extended range full-bore boat tail projectile was originally developed by PRB and brief details are: weight 46 kg; length with fuze 940 mm; and weight of TNT content 8 kg. Maximum range when fired by GC 45/GH N45/ G5 and G6 is 30 000 m and from the M198 maximum range is 24 000 m.

155 mm Cargo Round Model G1

This 155 mm cargo round entered production in 1990 for the French Army under the designation of the OGRE 155 G1 and contains 63 anti-tank and anti-personnel bomblets. It is fitted with a base bleed lock and is initiated by a time fuze. Brief details are: weight 46 kg and length wih fuze 920 mm. According to Giat Industries, when fired by 155 TR weapon and at a maximum range of 28 000 m, this round has an effective area against standing personnel of 5000 square metres, against prone personnel of 2500 square metres and against light armour of 200 square metres.

155 mm Mine Cargo Projectile

This 155 mm cargo projectile, which has yet to enter production, contains six anti-tank mines with a programmable fuze. Total weight of this projectile is 46 kg and maximum range is 18 000 m.

155 mm Illuminating Projectile

This has the same external shape as the Model 56/69 HE projectile and therefore uses the same firing tables. Brief details are: weight with fuze 43.5 kg and length with fuze 786 mm. Maximum range, when fired from 155 AU F1 self-propelled artillery system, is 21 100 m. The illuminating projectile has a luminous intensity of 1 million candelas which lasts for a period of 120 seconds.

Combustible 155 mm Charges

These are for use with the Giat Industries 155 mm AU F1 and AU F1 selfpropelled artillery systems. It consists of a skirt, base and a cover containing five propellant charges (Numbers 3 to 7). It is supplemented by two additional charges, 1 and 2, for practice firing.

Maximum muzzle velocity for 155 mm OE F1 projectile fired by AU F1:

Charge 3	Charge 4	Charge 5	Charge 6	Charge 7
490 m/s	586 m/s	695 m/s	790 m/s	810 m/s

Combustible 155 mm Charges

These have been designed for use with 155 mm NATO type weapons such as the M198, M109A3, FH-70 and the French 155 mm towed artillery system. It consists of a skirt, base and cover and four propellant charges (6 to 9) with additional bagged charges for velocities of between 260 and 480 m/s.

Maximum muzzle velocity for 155 mm OE F1 projectile:

Charge 6	Charge 7	Charge 8	Charge 9
586 m/s	705 m/s	810 m/s	830 m/s

130 mm Type HE ERFB BB NR 353

This 130 mm projectile was developed by PRB and can be fired from former Soviet 130 mm M-46 field guns and the equivalent Chinese weapon. Brief details are: projectile weight including fuze 31 kg; length with fuze 729 mm; and weight of TNT content 4 kg. Maximum range with base bleed motor is 36 000 m.

130 mm Range Enhancement Kit

This was originally developed by Luchaire for installation on existing 130 mm projectiles fired from the former Soviet 130 mm M-46 field gun and its Chinese equivalent. To take the base bleed unit the tail of the existing projectile has to be modified so that the base bleed unit can be screwed on. Brief details of kit are: outside diameter 129 mm; total length 141 mm; and total weight of kit 3.4 kg. Range comparison is as follows:

	Standard 130 mm	130 mm with Base Bleed
LENGTH (fuze)	660 mm	770 mm
WEIGHT (projectile)	33.3 kg	36.4 kg
RANGE (max)	27 490 m	33 000 m

105 mm Artillery Ammunition

This is fired by the new French 105 mm LG1 light gun as well as other standard 105 mm artillery systems, including the US M101 and M102 towed systems.

Туре	HE ER BB G1	HE BT G1 (semi)	WP BT G1 (semi)	WP ER BB G
LENGTH (cartridge with fuze)	850 mm	850 mm	850 mm	850 mm
LENGTH (projectile with fuze)	569 mm	569 mm	569 mm	569 mm
WEIGHT (cartridge with fuze)	18 kg	18 kg	18.4 kg	18.2 kg
WEIGHT (projectile with fuze)	13 kg	13.1 kg	13.5 kg	13.2 kg
WEIGHT (content)	2.5 kg	2.5 kg	2.5 kg	2.3 kg
TYPE (content)	TNT	TNT	WP	WP
RANGE (max)	17 500 m	17 500 m	15 000 m	15 000 m

In addition, Giat also manufactures other standard US types of 105 mm artillery ammunition including HE M1, smoke M60, smoke HC M84A1 and M314A3 illuminating.

120 mm Tank Ammunition

Three types of fin-stabilised 120 mm ammunition have been developed for the Giat Industries 120 mm smooth-bore gun fitted to the AMX-40 MBT and Brazilian EE-T1 Osorio MBTs, neither of which has so far entered production. The kinetic energy penetrator APFSDS-T round is designed to penetrate standard NATO armour targets at ranges of up to 7000 m but the useful combat range is 2000 m. This round is designated the OFL 120 G1 and will penetrate 550 mm of armour at a 60° angle. A training round for the APFSDS-T projectile has the same ballistics up to 1500 m. The HEAT-MP-T round is intended for general use.

The APFSDS-T round is designated the OFT 120 G1 while the HEAT-MP-T round is designated the OECC 120. Both rounds have a tracer element and use a semi-combustible cartridge case and all that remains after firing is the stub base of the cartridge.

SPECIFICATIONS

APFSDS-T	HEAT-MP-T
18.75 kg	24.8 kg
6.3 kg	13.9 kg
977 mm	995 mm
1650 m/s	1100 m/s
	18.75 kg 6.3 kg 977 mm

120 mm Leclerc MBT Ammunition

The above ammunition can be fired by the new Giat Industries Leclerc MBT but a new family of ammunition has been designed by Giat Industries specifically for this MBT. It consists of two key rounds: the APFSDS (OFL 120 F1) and HEAT-MP (OECC 120 F1), which differ in some details to the 120 mm ammunition developed for the AMX-40 and Osorio MBTs.

SPECIFICATIONS

Designation	OFL 120 F1	OECC 120 F1	BSCC
Туре	APFSDS-T	HEAT-MP-T	HEAT-MP-T (training)
WEIGHT (cartridge)	20.00 kg	24.3 kg	24.3 kg
WEIGHT (projectile)	7.3 kg	14.4 kg	14.4 kg
MUZZLE VELOCITY USEFUL COMBAT	1780 m/s	1100 m/s	1100 m/s
RANGE	2400 m	1280 m	1280 m

105 mm Tank Ammunition

These 105 mm fixed rounds are fired by the AMX-30 B2, AMX-30, modernised M47 and M48 tanks with French 105 mm guns and the AMX-13 light tank with FL-12 turret armed with 105 mm gun. The projectiles used for all these vehicles are identical but the cartridge case for the projectiles fired by the 105 mm armed AMX-13 is shorter than that used for the other AFVs. Muzzle velocities are valid only for the AMX-30 and not for the other three vehicles mentioned.



Giat Industries 120 mm ammunition for Leclerc MBT with APFSDS round in centre (Christopher F Foss)

Projectile type WEIGHT	APFSDS1	HEAT ²	HE ³	ILL ⁴	Smoke ⁵
projectile filling subcalibre projectile FILLING TYPE LENGTH	5.8 kg n/app 3.8 kg n/app	10.95 kg 0.78 kg n/app Hexolite	12.1 kg 2 kg n/app HE	11.5 kg 0.46 kg n/app Illuminant	12.8 kg 1.77 kg n/app WP
projectile overall DIAMETER OF SUB/CALIBRE PROJECTILE	541.5 mm 985 mm	465 mm 995 mm	444 mm 990 mm	444 mm 990 mm	444 mm 990 mm
SPLINES MUZZLE VELOCITY	26 mm 1525 m/s	n/app 1000 m/s	n/app 700 m/s	n/app 275 m/s	n/app 695 m/s

'Announced in June 1979 and entered production in 1981. Can also be fired by tanks armed with 105 mm rifled tank guns (eg British L7 series and American M68 series). Penetrator is of tungsten alloy and will penetrate 150 mm of armour plate inclined at 60° at 5000 m range. This round is called the OFL 105 F1 and will penetrate 460 mm of armour at an angle of 60°. More recent models are the OFL 105 G2 (m/v 1525 m/s) and the OFL 105 G3 (m/v 1490 m/s).

 $^{\circ}$ Called OCC or OBUS A, will penetrate 360 mm of armour at 0 $^{\circ}$ incidence or 150 mm at 60 $^{\circ}$ and will function up to 78 $^{\circ}$ incidence.

³Called OE and fitted with PD M51 or FUI 56 fuze. Training version called PLPN.

 4 Called OECL and will illuminate 300 m diameter area with more than 5 lux and a 900 m diameter area with more than 1 lux for 35 s.

⁵Called OFUM PH F1 and will lay smoke-screen 75 m wide which will last 40 s.

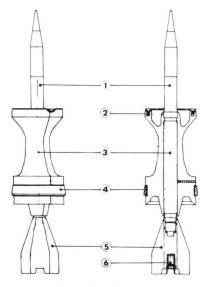
Giat Industries has introduced two new 105 mm tank gun training rounds. One is the BSCC 105 F1 which can be used for practice at all combat ranges. The other is the OXT 105 which can only be used at ranges up to 1200 m. Both are identical in shape and appearance to the OCC 105 F1 HEAT round and projectile and both have tracer elements. Both use normal firing and range tables but the OXT 105 can use these tables only up to 1200 m.

Type	BSCC 105 F1	OXT 105
LENGTH (projectile)	464 mm	468 mm
WEIGHT		
round	21 kg	12.15 kg
projectile	10.95 kg	4.00 kg
MUZZLE VELOCITY	1000 m/s	1100 m/s
SAFETY RANGE	8000 m	less than 6000 m

105 mm Fin-stabilised Ammunition

Five types of 105 mm fin-stabilised ammunition are produced for the AMX-10RC wheeled reconnaissance vehicle. The HEAT projectile can penetrate up to 350 mm of armour set at 0° incidence and 150 mm of armour set at an angle of 60°. The APFSDS projectile can penetrate NATO single and heavy tank targets. The smoke projectile can produce a screen 70 m wide for over 20 seconds.

Туре	HEAT-T	HE	Smoke	APFSDS-T	HEAT- Prac
DESIGNATION	OCC 105 F3	OE 105 F3	OFUM 105 F3	OFL 105 F3	BSCC F3
WEIGHT					
round	13.6 kg	13.5 kg	13.5 kg	12.8 kg	13.6 kg
projectile MUZZLE	5.6 kg	7.1 kg	7.2 kg	3.8 kg	5.6 kg
VELOCITY	1120 m/s	800 m/s	800 m/s	1400 m/s	1120 m/s



Main components of Giat Industries 105 mm APFSDS projectile (1) subprojectile (penetrator) (2) front ring (3) launching sabot (4) slip band (5) fin stabiliser (6) tracer

105 mm Ammunition for L7/M68 Rifled Guns

Giat Industries now manufactures 105 mm ammunition for the British L7 and US M68 rifled tank guns, all of these having a brass cartridge case and tracer.

SPEC	FICA	ATIONS
------	------	--------

Type	HEAT-T	HESH-T	TP/DS
DESIGNATION	NR 132	NR 133	NR 553
EQUIVALENT	US M456A1	US M383A2	UK L50A2
WEIGHT (cartridge)	21.80 kg	20.40 kg	12.00 kg
WEIGHT (projectile)	9.8 kg	10.80 kg	3.91 kg
MUZZLE VELOCITY	1173 m/s	731 m/s	1520 m/s
USEFUL COMBAT			
RANGE	3000 m	2000 m	1000 m

100 mm Ammunition for T-54/T-55/Type 59 MBTs

Giat Industries now manufactures ammunition for the 100 mm gun installed in former Soviet T-54/T-55 MBTs as well as the Chinese Type 59. Two types of APFSDS-T are produced, one for use in cold climates and one for use in hot climates.

SPECIFICATIONS

DESIGNATION	NR 352	NR 322
TYPE	COLD CLIMATE	HOT CLIMATE
WEIGHT (cartridge)	19.9 kg	19.85 kg
WEIGHT (projectile)	4.6 kg	4.6 kg
WEIGHT (penetrator)	2.8 kg	2.8 kg
MUZZLE VELOCITY	1425 m/s	1410 m/s

90 mm Ammunition

These 90 mm fin-stabilised fixed rounds are fired by the 90 mm gun mounted in the Panhard AML (4 \times 4) armoured car fitted with HE 90 turret, Panhard ERC 90 Lynx (6 \times 6) armoured car, modernised M24 Chaffee light tank, AMX-10 PAC 90 fire support vehicle, Panhard ERC 90 Sagaie (6 \times 6) armoured car, Renault VBC 90 (6 \times 6) armoured vehicle and the modernised AMX-13 light tank. The projectiles fired by all seven vehicles are identical but the cartridge cases for the last four are longer, heavier, have a higher

muzzle velocity and, therefore, a longer effective range than the projectiles fired by the first three.

Projectile type DESIGNATION	Canister ¹ ODR	HE ² OE 90 F1	HEAT ³ OCC 90-62	Smoke⁴ OFUM PH 90 F1
WEIGHT complete round projectile filling LENGTH (projectile) MUZZLE VELOCITY	8.95 kg 5.28 kg 4 kg 158 mm 640 m/s	8.95 kg 5.28 kg 0.945 kg 480 mm 640 m/s	7.1 kg 3.6 kg 0.67 kg 500 mm 750 m/s	9.07 kg 5.4 kg 0.8 kg 480 mm 640 m/s

Has 150-200 m effective range

The projectile fired by the first three vehicles has a muzzle velocity of 750 m/s with a 655 mm bag cartridge weighing 7.1 kg and a maximum range of 2300 m. The projectile fired by the last four vehicles has a muzzle velocity of 950 m/s with a 902 mm long cartridge weighing 8.95 kg and a maximum range of 2900 m. APFSDS projectile has a muzzle velocity of 1300 m/s, will penetrate 120 mm of armour at an incidence of 60° at a range of 2000 m and a triple target (10/25/60 mm) at an incidence of 60° at a range of 2000 m. The cartridge case for this projectile, which will be fired only by the last four vehicles, is 979 mm long with the projectile weighing 9.76 kg.

90 mm Ammunition for CS 90 (90 F 4) Gun

With the introduction of the Giat Industries CS 90 (90 F 4) 90 mm gun a new and revised range of ammunition has been introduced. The new 90 mm rounds are generally similar to the 90 mm rounds mentioned earlier but in some cases the characteristics have been revised. In addition to the range given in the table, there is a hollow charge practice round known as the BSCC 90 F1, which has the same characteristics as the HEAT OCC 90 Mle 62.

SPECIFICATIONS (90 m	m)					
Туре	APFSDS	HEAT	HE	HE LR	Smoke	Canister
DESIGNATION	OFL 90 F1	OCC 90 F2	OE 90 F1	OE 90 S	OFUM 90 F1	ODR 90 H2
WEIGHT						
complete	9.9 kg	8.9 kg	10.42 kg	12.6 kg	10.54 kg	10.42 kg
projectile	3.33 kg	3.65 kg	5.28 kg	7.2 kg	5.4 kg	5.28 kg
filling	n/a1	0.67 kg	0.945 kg	1.45 kg	0.8 kg	4.1 kg ²
LENGTH (overall)	958 mm	902 mm	886 mm	900 mm	886 mm	735 mm
MUZZLE VELOCITY	1275 m/s	950 m/s	750 m/s	700 m/s	750 m/s	750 m/s
USEFUL COMBAT						
RANGE	1660 m	1100 m	925 m	up to 9200 m	925 m	200 m

Penetrator weight is 2.33 kg

There is also a training round for the HEAT round called the BSCC



Giat Industries 90 mm, 105 mm and 120 mm APFSDS rounds with projectiles

²Practice version called OE 90 PLPN

³Will penetrate 320 mm of armour at 0° incidence

Will penetrate 120 mm of armour at 65° incidence

Will function up to 75° incidence

Practice version called BSCC F1

⁴Will lay smoke screen 50 m wide which will last 20-30 s

²Filling is approx 1050 8.7 mm lead balls

90 mm Ammunition for Cockerill Mk III Guns

Giat Industries now manufactures the wide range of former PRB ammunition for the Cockerill 90 mm Mk III gun installed in many armoured vehicles.

SPECIFICATIONS Type WEIGHT	APFSDS	HEAT	HE	Smoke	HESH	HEAT-HVY	Canister	HEAT-TP
(cartridge) WEIGHT	6.1 kg	7.7 kg	8.1 kg	8.4 kg	7.5 kg	8.2 kg	6.6 kg	7.7 kg
(projectile) MUZZLE	2.6 kg	4.1 kg	5.1 kg	5.3 kg	4.3 kg	5.1 kg	3.5 kg	4.1 kg
VELOCITY TRACER	1050 m/s yes	890 m/s yes	700 m/s yes	695 m/s yes	800 m/s yes	700 m/s yes	460 m/s no	890 m/s yes

76 mm Scorpion Ammunition

Giat can now manufacture ammunition for the 76 mm gun installed in the British Saladin (6×6) armoured car and in the Scorpion Combat Vehicle Reconnaissance (Tracked). This was previously made by PRB in Belgium.

SPECIFICATIONS

Туре	HE-T	HESH-T	HE-TP-T
Designation	NR 525	NR 180	NR 496
WEIGHT			
(cartridge)	7.80 kg	7.40 kg	7.80 kg
WEIGHT			
(projectile)	5.72 kg	5.25 kg	5.75 kg
MUZZLE VELOCITY	513 m/s	538 m/s	525 m/s

Giat Industries Medium Calibre Ammunition

The company can supply the following types of ammunition in the 20 mm to 40 mm calibre:

40 mm × 365 R (Manurhin) for Bofors L/70 guns

Armour-piercing tracer
High explosive incendiary
High explosive incendiary tracer
Pre-fragmented high explosive incendiary with proximity fuze
Target practice
Target practice tracer

40 mm × 311 R (Manurhin) for Bofors L/60 guns

Armour-piercing tracer High explosive incendiary High explosive incendiary tracer Target practice Target practice tracer

35 mm × 228 (Manurhin) for Oerlikon-Contraves Cannon

High explosive incendiary
High explosive incendiary
High explosive incendiary tracer
Semi-armour-piercing high explosive incendiary
Semi-armour-piercing high explosive incendiary tracer
Target practice
Target practice tracer
Target practice with short range

30 mm × 170 (Manurhin) for Oerlikon-Contraves Cannon

High explosive incendiary
High explosive incendiary tracer
Target practice
Target practice tracer

25 mm × 137 for Various Cannon

Armour-piercing hard core/tracer Armour-piercing discarding sabot High explosive incendiary tracer Semi-armour-piercing high explosive incendiary tracer Target practice tracer

20 mm × 139 (Manurhin) for Cannon

Armour-piercing tracer
Armour-piercing incendiary
Armour-piercing incendiary tracer
Armour-piercing discarding sabot
Target practice
Target practice tracer
High explosive incendiary
High explosive incendiary tracer
Semi-armour-piercing high explosive incendiary

20 mm × 128 (Manurhin) for Cannon

Armour-piercing hard core Armour-piercing hard core tracer High explosive incendiary High explosive incendiary tracer Semi-armour-piercing high explosive incendiary tracer Semi-armour-piercing high explosive incendiary

20 mm × 110 RB (Manurhin) for Cannon

Armour-piercing tracer
High explosive incendiary
High explosive incendiary tracer
Target practice
Target practice tracer

20 mm × 100 (Manurhin) for Cannon

High explosive incendiary High explosive incendiary tracer Target practice Target practice tracer

20 mm × 110 (Manurhin) for Cannon

Armour-piercing
Armour-piercing tracer
High explosive incendiary
High explosive incendiary tracer
Target practice
Target practice tracer

20 mm × 102 (Manurhin) for Cannon

Armour-piercing tracer
High explosive incendiary
Target practice
Target practice tracer

20 mm × 82 (Manurhin)

Armour-piercing incendiary
Armour-piercing tracer
High explosive incendiary
High explosive incendiary tracer
Target practice
Target practice tracer

(Also ammunition for 20 mm and 30 mm aircraft cannon)

Manufacturer: Giat Industries, 13 route de la Minière, Satory 78034, Versailles Cedex, France.

Telephone: 30 97 37 37 Fax: 30 97 39 00



Giat Industries 20 mm × 102 series ammunition

Thomson Brandt Armements Ammunition

155 mm Anti-Char à Effect Dirigé (ACED)

This projectile, also referred to as the 155 ACED, is now under advanced development to meet the requirements of the French Army and could be ready for production as early as 1995.

Prime contractor is Thomson Brandt Armements with Giat Industries being responsible for the projectile body, SAT for the infra-red seeker and Thomson-CSF for the MMW seeker.

The 155 ACED is a smart cargo projectile which carries three submunitions that are ejected out through the rear of the 155 mm projectile over the target area at an altitude of about 1000 m.

Once ejected from the projectile a parachute opens which slows down the submunition. This then starts to spin and scan for targets such as MBTs and self-propelled artillery systems. Once the target has been detected the explosively formed charge is fired into the vulnerable upper surfaces of the MBT. Maximum range, with a 52 calibre ordnance, is 25 000 m.

Also under development is the Obus de 100 mm à Correction de Trajectorie. Although this is for naval weapons it has applications in other weapons systems. It is intended for firing from the Creusot-Loire Industrie 100 mm Compact gun against aircraft and anti-ship missiles. It uses popout stabilising tail fins with in-flight course corrections being made by actuating smaller thruster motors spaced around the centre of the body The projectile is handled and fired using a fixed propellant case compatible with many existing naval guns.

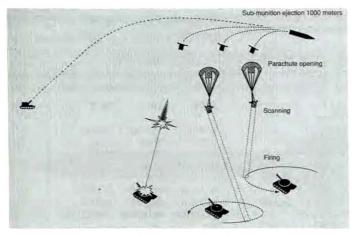
The company is also studying a 120 mm mortar bomb using similar submunitions to that of the 155 mm ACED.

155 mm Rocket-assisted Projectile

This 155 mm rocket-assisted projectile has been designed to be fired by the 155 mm Mk F3 self-propelled gun to a maximum range of 25 300 m and by the GCT gun to a maximum range of 30 500 m.

SPECIFICATIONS (RAP)

CALIBRE 155 mm WEIGHT (projectile) 44 kg **FILLING** 7.6 kg RDX/TNT PD M557 FUZE LENGTH 810 mm



Thomson Brandt Armements 155 mm Anti-Char à Effect Dirigé (ACED) projectile showing method of operation



Left: 155 mm rocket-assisted projectile; centre: 81 mm AP projectile F811; right: 81 mm LP projectile

81 mm Armour-piercing Projectile F811

This 81 mm armour-piercing projectile is designed to be fired from the Thomson Brandt Armements 81 mm MCB 81 mortar cannon. Muzzle velocity is 1000 m/s and remaining velocity, at a range of 1000 m, is 900 m/s. The MCB 81 mortar cannon can also fire the Thomson Brandt LP long-range projectile up to a range of 7600 m as well as all Thomson Brandt 81 mm mortar bombs including the M61 and M57D HE bombs, smoke and illuminating bombs. The F811 is now in production.

SPECIFICATIONS		
Type	APFSDS	HE
DESIGNATION	F811	LP
CALIBRE	81.4 mm	81.4 mm
WEIGHT		
complete	3.65 kg	7.4 kg
projectile	0.87 kg	7.1 kg
LENGTH		
complete	640 mm	579 mm
projectile	281 mm	579 mm
MUZZLE VELOCITY	1000 m/s	400 m/s
RANGE	1100 m	7600 m
PENETRATION	50 mm	n/a
(steel plate, 45°, 1000 n	n)	

60 mm Gun Mortar Ammunition

This ammunition is intended for use in the Thomson Brandt 60 mm gun mortars although some may be fired from conventional 60 mm mortars.

DESIGNATION	APFSDS	HEAT	LP	M61	M63	M72	
APPLICATION	MCB 60 LR	MCB 60 LR MCB 60	MCB 60 LR	MCB 60	MCB 60	MCB 60	
WEIGHT COMPLETE	2.28 kg	1.45 kg	2.20 kg	1.73 kg	1.55 kg	1.75 kg	
LENGTH	580 mm	347 mm	379 mm	307 mm	320 mm	307 mm	
MAX RANGE	1000 m	500 m	5150 m	2050 m	2300 m	3350 m	

Notes:

APFSDS will penetrate 25 mm of armour plate at an incidence of 45° at a range of 1000 m

HEAT has a piezo-electric fuze with explosive content being RDX/TNT

LP is a long-range HE bomb with a TNT filling

M61 is an HE bomb with a TNT filling

M63 is an illumination projectile

M72 is an HE bomb with a TNT filling

Manufacturer: Thomson Brandt Armements, Tour Chenonceaux, 204 Rond Point de Sèvres, F-92516 Boulogne Billancourt Cedex, France. Telephone: (1) 46 20 65 65 Telex: 631882 F

GERMANY

Diehl Ammunition Programme

The Ordnance Division of Diehl has been involved in the design, development and production of ammunition since the late 1950s. In addition to the ammunition listed below, the company is also involved in the design, development and production of mortar bombs (including the 120 mm terminally guided Bussard which was developed to the prototype stage but not placed in production), mines, fuzes, hand grenades and specialised components of ammunition. Listed below is a résumé of current ammunition that has an AFV or artillery application. Ammunition is also manufactured for aircraft (eg 20 mm Vulcan cannon and 27 mm Mauser for Tornado MRCA) and naval weapons (eg for OTO Melara 76 mm Compact gun).

Diehl has also developed the 120 mm under armour mortar system which has for trials purposes been installed on a Krauss-Maffei Puma armoured combat vehicle and full details of this system, still at the prototype stage, are given earlier on page 16 of this edition.

20 mm HEI Model M.DN 71

This can be fired from the M61A1, M39A2 cannon. The projectile weighs 98 g, contains 5 g of explosive and has a muzzle velocity of 1030 m/s. The fuze is not armed until it is 14 m from the weapon and has a delayed action which ensures that in most cases it has penetrated the target before detonating.

20 mm DM 111 Shrapnel

This round is fired from the Rheinmetall 20 mm MK 20 Rh 202 cannon and weighs 118 g with a muzzle velocity of 1055 m/s. It contains about 120 fragments which will penetrate 2 mm of Dural F 40 at a range of 70 m. This would be used by the twin 20 mm Rheinmetall light anti-aircraft gun when used in the ground defence role against attacking troops.



20 mm shrapnel projectile DM 111

20 mm × 139 Rounds

These four rounds have been developed by Diehl and are fired by the 20 mm HS 820, MK 693 and Rh 202 cannon. All have similar trajectories so aiming can take place with the same gun sight. All four rounds use the same propellant case (DM 1A1) and primer (DM 64).

Type DESIGNATION WEIGHT	HEI M599	HEI DM 81	HEI DM 101	TP-T DM 48A1
cartridge projectile propellant	317 g 122 kg 51 g	315 g 120 g 51 a	315 g 120 g 51 a	317 g 122 g
MUZZLE VELOCITY TRACER	1045 m/s red	1055 m/s red	1055 m/s	51 g 1045 m/s red
BURNING TIME	3.4 s	3.4 s	none	3.4 s

25 mm × 137 Rounds

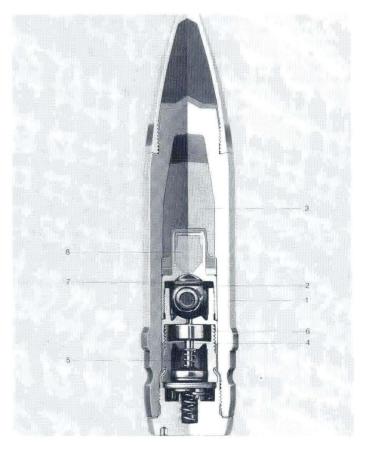
This ammunition is now in its final stages of development.

Туре	SAPHE	HEI	Practice-T
WEIGHT	105 1 =	105 . 4 -	105 1 =
projectile	$195 \pm 4 g$	$195 \pm 4 g$	$195 \pm 4 g$
propellant	90 g	90 g	90 g
fuze	37 g	20 g	none
complete round	512 g	512 g	512 g
LENGTH			_
complete round	222 mm	222 mm	222 mm
MUZZLE VELOCITY	1100 m/s	1100 m/s	1100 m/s
SELF-DESTRUCT TIME	3.7-5 s	3.7-5 s	none

35 mm DM 31 MP with Base Fuze DM 821

This round can be used against aircraft, helicopters and ground targets.

WEIGHT	
projectile	550 g
propellant	340 g
fuze	82 g
complete round	1.57 kg
LENGTH	
complete round	387 mm
MUZZLE VELOCITY	1180 m/s
SELF-DESTRUCT TIME	$6.1 \pm 1.5 s$



Diehl 20 mm DM 101 HEI projectile showing: (1) detonator (2) DM 771 base fuze rotor (3) main charge (4) firing pin (5) pressure spring (6) coiled tape (7) safety circlip (8) booster

40 mm × 311 Rounds for L/60 Weapons

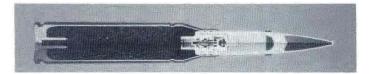
These fixed rounds are fired by towed 40 mm Bofors L/60 anti-aircraft guns and the M42 twin 40 mm self-propelled anti-aircraft gun system.

Type WEIGHT	HEIT	AP-T	TP-T
cartridge	2.05 kg	2.09 kg	2.05 kg
projectile	930 g	930 g	930 g
propellant explosive charge LENGTH	275 g 95 g	275 g none	275 g none
cartridge	447 mm	447 mm	477 mm
MUZZLE VELOCITY	860 m/s	860 m/s	860 m/s
MAX RANGE	10 000 m	10 000 m	10 000 m
TRACER COLOUR	red	red	red

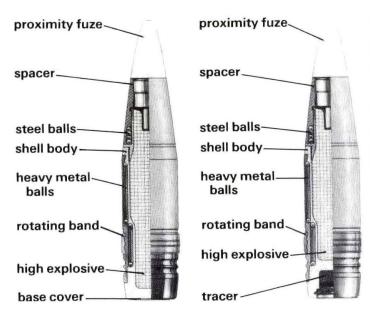
40 mm × 365 Rounds for L/70

These fixed rounds are fired by 40 mm Bofors L/70 anti-aircraft guns.

Type DESIGNATION FUZE	HEI-T DM 31A3 PSDS DM81 A1	HEI-T DM 81A2 DM321	TP-T DM 68 none
LENGTH			
cartridge	534 mm	534 mm	534 mm
WEIGHT			
cartridge	2.51 kg	2.51 kg	2.51 kg
projectile	960 g	960 g	960 g
charge	120 g	120 g	120 g
propellant	475 g	475 g	475 g
MUZZLE VELOCITY	1005 m/s	1005 m/s	1005 m/s
MAX RANGE	12 000 m	12 000 m	12 000 m
TRACER COLOUR	red	red	red
TRACER BURN TIME	4.5 s	4.5 s	4.5 s



Diehl 35 mm DM 31 MP round with base fuze DM 821 cutaway to show main parts



Diehl 40 mm prefragmented HE projectiles with HE (left) and HE-T (right)

Diehl now produces a range of 40 mm prefragmented HE projectiles for Bofors L/70 guns. All use proximity fuzes and have a maximum range of 12 000 m. Other details are as follows:

Туре	HE-T-PF	HE-PF	HE-T-PF	HE-PF
DESIGNATION	M-DN 51	M-DN 61	M-DN 71	M-DN 81
WEIGHT				
cartridge	2.51 kg	2.51 kg	2.51 kg	2.51 kg
projectile	0.96 kg	0.96 kg	0.96 kg	0.96 kg
charge	72 g	83 g	103 g	115 g
propellant	475 g	475 g	475 g	475 g
LENGTH	534 mm	534 mm	534 mm	534 mm
MUZZLE VELOCITY	1005 m/s	1005 m/s	1005 m/s	1005 m/s
TRACER	red	n/a	red	n/a

105 mm TPFSDS-T Round DM 148

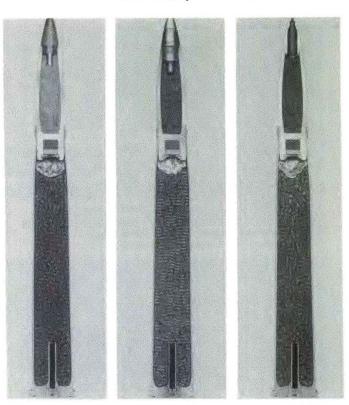
This is a low-cost practice round for the 105 mm DM 13/23/33 APFSDS-T round and, regardless of elevation and temperature, the requirement defining a danger area of 7.5 km in firing direction and of 2.1 km to both sides is met. The principle of operation of the Diehl TPFSDS-T projectile is that one of



DM148 Diehl TPFSDS-T round cutaway to show main components



DM148 Diehl TPFSDS-T round at point of separation



Three 40 mm × 365 rounds fired by Bofors L/70 anti-aircraft gun. Left to right: DM 31 A3 (HEI-T), DM 81 A2 (HEI-T), and DM 68 (TP-T)

the five pyrotechnic elements in the rear part of the penetrator detonates at a range of between 3100 and 4500 m causing the fin section to separate. Both these unstable parts fall to the ground well within the defined danger zone of 7500 m.

Type DESIGNATION	APFSDS-T DM23	TPFSDS-T DM148
WEIGHT projectile without sabot	4.2 kg	2.14 kg
sabot	2.075 kg	2.16 kg
propellant	5.8 kg	5.4 kg
LENGTH		
projectile without sabot	416 mm	427 mm
sabot	203.8 mm	212.4 mm
CARTRIDGE CASE	DM 30	DM 30
PRIMER	DM 32A1	DM 102
PROPELLANT	N 5470	D 5630
MUZZLE VELOCITY	1455 m/s	1505 m/s

Note: Diehl also produces the 105 mm DM 33 APFSDS-T round (improved DM 23) and the 105 mm HEAT-TP-T DM 68 round.

Terminally Guided Artillery Projectile

Diehl is studying a 155 mm calibre Endphasengelenktes Artillerie Projektil (terminally guided artillery projectile). The projectile will have a ballistic flight trajectory followed by an aerodynamic gliding phase during which armoured or hardened targets will be detected by a millimetre wave radar seeker. The target will be subsequently tracked and destroyed

Manufacturer: Diehl-Wehrtechnik, 8505 Röthenbach, Fischbachstrasse 20, Federal Republic of Germany

Telex: 622591-42 Telephone: (911) 509-1

Fax: (911) 509-2510

Rheinmetall Ammunition

The headquarters and main manufacturing facilities of the Rheinmetall Group are at Düsseldorf, with the company-owned testing and proving ground at Unterlüss near Celle. Affiliated to the company are NWM de Kruithoorn BV of the Netherlands (there is a separate entry in this section for this company's products) and Nico-Pyrotechnik of Trittau, Germany.

The ammunition manufacturing programme of Rheinmetall covers combat and practice ammunition from 20 mm up to 203 mm. In addition to a wide range of ammunition, the company manufactures turrets and weapon systems for armoured vehicles, 105 mm rifled (for Leopard 1 tanks and refitted German M48 tanks) and 120 mm smooth-bore (for Leopard 2 MBTs) tank guns, anti-tank weapons, towed guns and howitzers (including FH-70). Also undertaken is the development and production of ordnance for tank destroyers and self-propelled artillery, anti-aircraft guns (single and twin 20 mm), 20 mm automatic cannon MK 20 Rh 202 for installation in AFVs such as the Marder 1 ICV and the Luchs reconnaissance vehicle, infantry weapons (MG3 machine gun which has many applications), primers, minesweeping equipment, and mechanical and electronic ignition systems. The company also conducts system studies, electronic measuring and control systems and the planning and export of production facilities.

Precision Munitions

Rheinmetall was developing the ZEPL smart munition for 155 mm weapons but it eventually teamed with Diehl on the SMArt 155 mm projectile for which there is a separate entry later in this section. Rheinmetall was also working on the EPHRAM terminal-guided tube-launched projectile but this stopped in favour of the NATO Autonomous Precision Guided Munition (APGM) programme (Jane's Armoured Fighting Vehicle Retrofit Systems 1990-91, page 99). All work on this has also now stopped.

Rheinmetall Carrier Projectiles

Some years ago Rheinmetall started development of a new 155 mm projectile with an improved range and kill probability compared to the M483 ICM. The BWB provided some funds for further development and first test rounds were fired in mid-1983. Two projectiles have been developed, the Rh 49 and the RB 63, the latter number referring to the number of bomblets carried. The RB 63 is a co-development with BPD of Italy

The Rh 49 and RB 63 can be fired by 155 mm systems such as the FH-70. With charge eight the RB 63 can achieve a range of 22 400 m; the Rh 49 with base bleed can achieve a range of 30 000 m.

The RB 63 is designated the DM642 by the German Army. It consists of a steel shell body, aluminium base and a filling of 63 bomblets each with a self-destruct device.

After firing, the fuze will, after the time setting has elapsed, ignite the expulsion charge at a height of 300 to 500 m. The bomblets are dispersed over the target area due to the centrifugal forces created by the spin of the carrier shell.

Each bomblet consists of a steel body giving optimum fragmentation effect, a shaped charge and an impact fuze. If the impact fuze does not function due to a very soft impact area, for example snow, a self destructive element will detonate the bomblet after a few seconds.

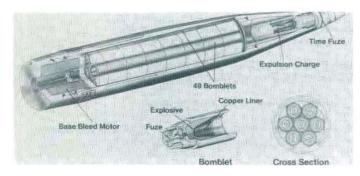
In case both impact and self-destruct systems do not operate, a back-up safety has been provided in the fuze mechanism. These features provide maximum safety for own troops when advancing.

For increased armour penetrating characteristics, the bomblet has been fitted with spin-brakes which reduce the spin rate before impact. A nylon ribbon attached to the arming screw of the fuze serves two purposes, first arming the bomblet fuze after expulsion and secondly stabilising the bomblet during its fall to the ground.

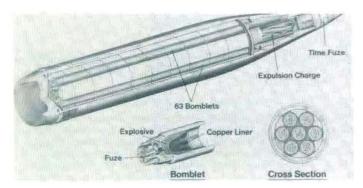
More recently, the 155 mm projectile with 49 bomblets and a base bleed unit has been called the Extended Range Bomblet Shell (ERBS) 155 mm. This projectile can be fired up to 28.8 km from a 39 calibre barrelled howitzer such as the FH-70, with the existing charge system. A further increase of the range up to 35 km can be achieved by using a 52 calibre ordnance

SPECIFICATIONS (ERBS)

CALIBRE 155 mm LENGTH (with fuze) 896 mm WEIGHT 47.0 kg FUZE DM163 or M577



155 mm Rh 49 long-range projectile



155 mm RB 63 projectile



Rheinmetall-produced 155 mm howitzer projectiles include (1) illuminating, (2) smoke and (3) standard HE M107

MAX VELOCITY	
(FH-70)	815 m/s
MAX RANGE	
(FH-70)	28.8 km
PAYLOAD	49 bomblets
BOMBLET	
weight	290 g
diameter	42 mm
length	95 mm
delay time	15 s (approx)

155 mm MTLS Unimodular Charge System

Rheinmetall has developed the Unimodular Charge System for the new German PzH 2000 155 mm self-propelled artillery system. This is still at the prototype stage.

This has five completely identical modules which are loaded automatically in the case of the PzH 2000, or manually with other systems. Firing the 155 mm PzH 2000 (or the Extended Range Ordnance gun) with the Unimodular Charge System and the L15A1 projectiles, a range of 30 000 m

The modules are constructed symmetrically around the axis so there is no special loading orientation to be observed. It is possible to ignite the module from both sides. The minimum charge consists of just one module and any number, up to six, can be loaded. In this way there is no remaining charge as is the case using standard charge systems.

All of the modules are identical which maintains ammunition flow logistics and makes training much easier. The Unimodular Charge System can be used in all current artillery systems, for example the 155 mm FH-70. In the case of the latter, five modules will bring the projectile L15A1 up to the same range as charge eight does. The Unimodular Charge System can be packaged in the normal package system.

155 mm Ammunition

The ammunition family developed for the International FH-70 consists of an HE projectile, illuminating projectile and a smoke projectile, which can also be fired by the German M109G self-propelled howitzer (a modified version of the American M109). The illuminating and smoke projectiles were developed by Rheinmetall and the company is also developing the extended range projectile which will have a range of about 30 000 m.

Projectile	HE	Illuminating	Smoke
DESIGNATION	M107*	DM106	DM105
PROJECTILE WEIGHT	43.5 kg	43.5 kg	43.5 kg
PROJECTILE LENGTH	700 mm	875 mm	875 mm
NUMBER OF PROPELLING			
CHARGES	11	8	8
MAX RANGE	18 000 m	24 000 m	24 000 m

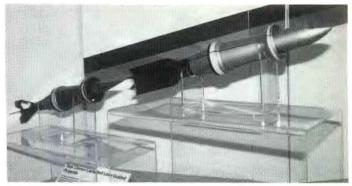
^{*} Standard American M107 projectile made by Rheinmetall.

Anti-helicopter Rounds

Rheinmetall has carried out research on two projectiles which will have an anti-helicopter capability and will also enable existing 105 mm and 120 mm tank guns to engage tank targets at longer battlefield ranges.

One projectile uses a three-part sabot and when fired follows a ballistic trajectory for the first 1000 m. At that range a sensor developed by BGT will be activated and fins will unfold from the projectile body to control homing onto a target. This projectile will have a range of between 2500 and 5000 m and will be fired at a muzzle velocity of 1100 m/s.

The second projectile will be laser-guided. This project is in an early stage of development but it is planned that it will use a four-segment sabot and have a range of 5000 m. The projectile will compute and control its trajectory by evaluating miss-distance information received from the target tracking beam. Muzzle velocity will be 1100 m/s. At present there is no German Government funding for either of these two projectiles.



Mock-ups of planned Rheinmetall anti-helicopter projectiles with laserguided projectile in foreground (lan Hogg)

120 mm Fixed Tank Ammunition

This 120 mm fixed tank ammunition has been designed by Rheinmetall to be fired from the Rheinmetall-developed 120 mm smooth-bore gun installed in the Leopard 2 MBT and US M1A1/M1A2 Abrams MBTs. The APFSDS-T round is used against armoured targets and the HEAT-MP against armoured and other battlefield targets. In addition, this ammunition can also be fired by the new Italian C1, Israeli Merkava Mk 3 and the French Leclerc MBTs.

The current production APFSDS-T round is the DM33, earlier versions being the DM13 and DM23. By mid-1992, development of the fourth generation 120 mm DM43 APFSDS-T round had almost been completed. this being a joint development between Rheinmetall of Germany and Giat of France. This round has a thinner penetrator with an increased length-todiameter ratio and can be fired from the Leopard 2 and Leclerc MBTs. The projectile consists of a sabot and a penetrator with a fin-tracer assembly. The cartridge case is combustible with the exception of the base which is made of steel containing the primer. The cartridge case is fitted with a grain type propellant. The training equivalent of the DM33 is the APFSDS-T-TP (LKL) DM38

The current production HEAT-MP-T (MZ) round is the DM12. The projectile consists of a body filled with a shaped charge and equipped with a piezoelectric sensor, a base detonating fuze and a tail assembly containing the tracer element. The cartridge case is combustible with the exception of the base which is made of steel, containing the primer. The cartridge case is filled with stick propellant. The training equivalent of the DM12 is the HEAT-MP-T-TP (MZ-ÜB) DM18.

The 120 mm Rheinmetall smooth-bore gun is also installed in the US M1A1/M1A2 MBT and details of the US ammunition, which can also be fired by the Leopard 2, are given in the United States section.

CD	ECI	EIC	ATI	ONS
3			MI	CIAO

SECULION HONS		
Туре	APFSDS-T	HEAT-MP-T
DESIGNATION	DM33	DM12
WEIGHT		
cartridge	19 kg	23 kg
projectile .	7.3 kg	13.5 kg
penetrator	4.6 kg	1.8 kg
propellant	7.6 kg	5.5 kg
MUZZLE VELOCITY	1650 m/s	1140 m/s
PROPELLANT TYPE	7-hole grain type	single base
PRIMER	DM72/DM92	DM35



Rheinmetall-developed 120 mm APFSDS-T (left) and HEAT-MP (right) rounds

120 mm and 105 mm Tank Practice Ammunition

Rheinmetall Wehrtechnik has introduced a novel approach to the design of modern KE practice ammunition by combining the Lochkegelleitwerk (LKL) with a KE penetrator body. The LKL is a cone base attached to the projectile rod tail and this base is pierced with nine holes that run from front to rear. The hole size is accurately machined to allow a particular aerodynamic law to take effect. At low velocities air passes freely through the holes with little or no effect on the drag of the cone. At velocities of about Mach 2 pressure waves build up in the cones which prevent more air from passing through the holes, so directing it over the tail of the cone. Eddies are produced which effectively cause drag and reduce the velocity of the projectile and, hence, the range.

In appearance and handling, an LKL round resembles an APDS round. As it is fired the sabot falls away but once in flight the LKL effect comes into play after about 3500 m. Up to that range the projectile behaves normally.

After 3500 m the LKL effect reduces the velocity of the projectile to the extent that an APDS-simulated projectile has a range of about 7500 m instead of 30 000 m plus. A lateral safety zone about 2100 m wide at 7500 m will be required for a tank gun elevated to over 10°

To date, Rheinmetall has applied the LKL principle to two types of tank gun ammunition, 105 and 120 mm. The 105 mm is used in L7/M68 guns and the 120 mm in the 120 mm Rheinmetall smooth-bore gun. Both calibres are identical in action and use, but the LKL cone for the 105 mm round is solid (apart from the holes) and the 120 mm cone is hollow. Both have near-identical range performances.

In the USA Alliant Techsystems has developed the LKL concept for the 120 mm M865 training round, for use with the 120 mm M256 gun installed in the M1A1/M1A2 Abrams MBT. This round will be used as the training equivalent for the M827 and M829 APFSDS-T rounds.



SPECIFICATIONS		
CALIBRE (LKL)	105 mm	120 mm
WEIGHT		
complete round	16.2 kg	18.4 kg
projectile/sabot	4.5 kg	5.9 kg
projectile	2.6 kg	3.2 kg
propellant	$6 \pm 0.3 \text{ kg}$	$8.2 \pm 0.3 \text{ kg}$
DIAMETER		
projectile	38 mm	38 mm
tail cone	80 mm	85 mm
MUZZLE VELOCITY	1640 m/s	1700 m/s
MAX RANGE (10° elevation)	7500 m	7500 m

Rheinmetall tank practice projectile with Lochkegelleitwerk (LKL)

105 mm Fixed Tank Ammunition

Rheinmetall manufactures the following 105 mm fixed ammunition for the Leopard 1 and M48 tanks armed with the standard L7/M68 rifled tank guns.



Rheinmetall-produced 105 mm tank gun ammunition (left to right) APFSDS-T, APFSDS-T-LKL, HEAT-MP-T, HEAT-TP, HESH-T, HESH-TP, Illuminating

SPECIFICATIONS Type CALIBRE GERMAN DESIGNATION WEIGHT	APFSDS-T	APFSDS-T-LKL	HEAT-MP-T (modified)	HEAT-TP	HESH-T	HESH-TP	ILL
	105 mm	105 mm	105 mm	105 mm	105 mm	105 mm	105mm
	DM43	DM128	n/a	DM68	DM512	DM78	DM16
projectile	6.1 kg	4.5 kg	10.3 kg	10.3 kg	11.3 kg	11.3 kg	16 kg
complete round	18 kg	16.8 kg	21.7 kg	21.7 kg	20.9 kg	20.9 kg	22.7 kg
LENGTH (complete round)	941 mm	916 mm	999 mm	999 mm	929 mm	929 mm	940 mm
MUZZLE VELOCITY	1475 m/s	1640 m/s	1174 m/s	1174 m/s	737 m/s	737 m/s	280 m/s

Ammunition for Rheinmetall MK 35/50 Rh 503 Cannon

The Rheinmetall dual calibre (35/50 mm) automatic cannon MK 35/50 Rh 503 has been developed under contract to the BWB as the main armament of the Marder 2 infantry fighting vehicle. Development of the Marder 2 was cancelled by the Germany MoD in December 1992 so there is no immediate production application for this weapon.

The original idea was that, initially, the weapon would fire performance improved ammunition of the 35 \times 228 mm type and, as the threat changed, the barrel would be changed and the weapon could then fire new 50 \times 330 mm ammunition called 'Supershot'.

35 mm APFSDS-T

This has a sub-calibre, fin-stabilised projectile, with a conventional pushpull sabot with a new tungsten penetrator which is effective against all types of armour.

35 mm HE

The HE round has an electronic time fuze in the weapon which is individually set. This is claimed to give increased lethality when compared to point detonating ammunition with an impact fuze. In addition, this allows detonation between 5 to 10 m/s above the ground even when firing several rounds against area targets. The time set function is in addition to the impact and self-destruct fuze functioning.

50 mm APFSDS-T

The cylindrical 'Supershot' configuration allows use of a 'pull' sabot instead of a conventional sabot with a plastic obturator. Because the pull sabot has only one guiding flange, instead of two, it leaves more space for the propellant charge, so allowing the use of pre-pressed propellants. Thus, muzzle velocity of the 50 mm 'Supershot' is nearly twice that of the potential muzzle energy of an improved 35 mm APFSDS round.

In the 'Supershot' the projectile is only partly embedded in the propellant

charge, resulting in a high inner ballistic efficiency. With the increased muzzle velocity, the hit probability of 'Supershot' is also enhanced.

According to Rheinmetall, in respect of terminal ballistics, the 'Supershot' has up to 50 per cent more power than an improved 35 mm APFSDS ammunition.

50 mm HE

With an electronic time fuze the 'Supershot' configuration allows many design options for the HE round. Two types of HE round designs are favoured. One is a low velocity full calibre round with a high payload and the other is a high velocity sub-calibre round with a greater range.

SPECIFICATIONS		
AMMUNITION TYPE	APFSDS-T	APFSDS-T
CALIBRE	35 × 228 mm	$50 \times 330 \text{ mm}$
DESIGN GAS PRESSURE		
AT 21° C	4100 bar	4800 bar
CARTRIDGE LENGTH	385 mm	385 mm
STOWAGE VOLUME	914 ccm	914 ccm
PROJECTILE MASS	430 g	700 g
FLIGHT PROJECTILE		
MASS	295 g	440 g
LENGTH-TO-DIAMETER		
RATIO	19/1	21/1
MUZZLE VELOCITY	1480 m/s	1600 m/s
VELOCITY AT 2000 m		
RANGE	1230 m/s	1360 m/s

35 mm × 228 Ammunition

For use with the Gepard twin 35 mm self-propelled anti-aircraft gun system used by the German Army, Rheinmetall is developing a new 35 mm \times 228 round called the Frangible Armour Piercing Discarding Sabot. This has a muzzle velocity of 1420 m/s with the projectile weighing about 380 g.

20 mm × 139 Ammunition

The 20 mm x 139 fixed ammunition is used in the following cannon: Rheinmetall MK 20 Rh 202, HSS 820, Oerlikon KAD, Giat M693 (F2) and M139 (USA). The MK 20 Rh 202 is installed in several mountings including the Rheinmetall 20 mm AA Twin Gun Air Defence System, the Norwegian 20 mm automatic anti-aircraft gun FK 20-2, the German Marder 1 ICV and Luchs 8 \times 8 reconnaissance vehicle, the Italian FIAT/OTO Melara Type 6616 armoured car, and Rheinmetall's TS-7, TF 20.15 and TF 20.5 A turrets and S-20 naval mount.

Manufacturer: Rheinmetall GmbH, Ulmenstrasse 125, D-4000 Düsseldorf,

Federal Republic of Germany Telephone: (0211) 447-01 T Telex: 858 33-0

Fax: (0211) 48 32 90

20 mm x 139 ammunition manufactured by Rheinmetall for MK 20 Rh 202 cannon (from left to right) HEIT, HEI, API-T, APDS-T, TP-T, and Break-up



SPECIFICATIONS							
Type	APDS-T	API-T	HEI	HEI-T	TP	TP-T	Break-up
DESIGNATION	DM63	DM43A1	n/a	DM81	DM48	DM48A1	DM78A1
WEIGHT							
projectile	108 g	111 g	120 g				
propellant	56.5 g	53 g	51 g				
explosive	none	none	6.5 g	7.1 g	none	none	none
complete round	310 g	310 g	317 g	315 g	317 g	317 g	317 g
MUZZLE VELOCITY	1150 m/s	1100 m/s	1045 m/s				
TRACE COLOUR	orange	orange	none	orange	none	orange	none
	or red	or red		or red		or red	
TRACE BURN TIME	1.2 s	1.4 s	n/app	3.5 s	n/app	3.5 s	n/app

API-T projectile will penetrate 32 mm of armour at 0° incidence at 1000 m range 24 mm of armour at 30° incidence at 1000 m range 8 mm of armour at 60° incidence at 1000 m range

SMArt 155 mm Projectile

Late in 1988 a consortium of Diehl and Rheinmetall was awarded a full scale engineering development contract from the BWB for the SMArt 155 (Sensor Fuzed Munition for Artillery) 155 mm, which is the German equivalent of the US Army's SADARM (Sense And Destroy Armor Munition) programme

Until then Diehl and Rheinmetall had been working on separate contracts with the Diehl projectile being called the HABICHT and the Rheinmetall projectile being called the ZEPL.

Under current plans, it is expected that full scale development will be completed in 1994, by which time all key tests will have been completed. The first drop test with a fully functioning warhead was successfully completed early in 1992 with a fully functional firing system expected to be finalised early in 1993.

The SMArt 155 projectile consists of four subsystems:

- (1) thin-walled carrier projectile whose exterior ballistics match the DM612/DM642 round
- (2) base plug
- (3) expulsion unit
- (4) two submunitions.

Each submunition consists of three key sub-assemblies: orientation and stabilisation unit; sensor fuze system; and the lethal mechanism.

The orientation and stabilisation unit comprises a drag chute, three despin flaps and an autorotating chute. The first two components control the aerodynamics of the sequence of function after ejection of the submunitions from the carrier shell, whereas the scanning of the target area in an inward spiral motion is controlled by the autorotating chute.

A multi-channel IR/MMW sensor system, a digital signal processor and the power supply unit are the components of the sensor fuze system.

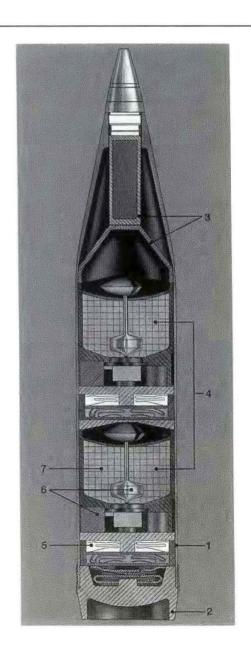
The sensor system receives the signals radiated from or reflected by the targets and the surrounding background. These signals are processed by the algorithm implemented on the DSP boards resulting in reliable detection of armoured targets even under adverse weather and background clutter conditions and with a high level of false target rejection.

The lethal mechanism consists of the Explosively Formed Penetrator (EFP) warhead and the safe and arming unit.

The full sequence of function of the 155 mm SMArt projectile is as follows:

- setting of the time fuze on the projectile
- loading the projectile and charge and then firing
- ballistic flight (3)

Sectioned SMArt 155 mm projectile showing key components (1) thin walled carrier projectile (2) Base plug (3) expulsion unit (4) 2 submunitions (5) orientation and stabilisation unit (6) sensor fuze system (7) lethal mechanism



100 AMMUNITION / Germany — Greece

- the time fuze event fires the expulsion charge
- the pressure fuze in the ogive ejects the submunitions (5)
- deceleration and despinning (6)activation of the power supply
- transition to vertical spinning descent (8)
- (9) IR sensor unfolds
- (10) algorithm adapts to background and clutter conditions
- (11) safe and arm event
- (12) submunition ready to function
- (13) scanning target area
- (14) target detected
- (15) computation of aim-point on target
- (16) firing of EFP charge

- (17) explosive forging of the penetrator slug
- (18) penetrator accelerated towards the target
- (19) target penetrated
- (20) target destroyed by behind-armour effects.

The SMArt 155 will be fired from the German artillery's existing 155 mm FH-70 towed artillery systems, the upgraded M109s and the new PzH 2000 self-propelled artillery system which is currently still at the prototype stage.

Status: Full scale engineering development for BWB.

Manufacturer: Gesellschaft Für Intelligente Wirksysteme mbH (GIWS),

Bahnhofsplatz 6, D-8500 Nürnberg 70, Germany.

Telephone: 0911 947 2100 Telex: 623997 Fax: 0911 243561

GREECE

PYRKAL Ammunition

The Greek Powder & Cartridge Company SA (PYRKAL) was founded in 1874 and has been the permanent supplier of ammunition materials to the Hellenic Armed Forces since then. The company has three manufacturing plants, at Hymettus, Lavrion and Elefsis. All the ammunition produced at these plants conforms fully to American and/or NATO military specifications. The product range includes the following, in addition to small arms ammunition, mortar bombs and pyrotechnics:

HEI, HEI-T, TP, TP-T, NM 75 MP; for HS 820, Rh 202 20 × 139 mm

and Mk 693 cannon

HEI, HEI-T, TP, TP-T, SAP-HEI (High Performance), 20 mm Oerlikon

SAP/HEI-T SD; for AA Mark 2 and Mark 4 Oerlikon

cannon

TP (M55A2 Vulcan), HEI (M56A3 Vulcan), SAP/HEI-T 20 × 102 mm

SD; for M39 and M61 cannon

HE, HEI, TP; for DEFA TYPE 551, 552, 553, 554 30 mm DEFA

35 mm Oerlikon HEI, HEI-T, TP, TP-T; for Oerlikon-Contraves 35 mm

HE-T, AP-T, TP, TP-T; for Bofors 40 mm L/60 40 mm Bofors 40 mm Bofors HEI-T M2, TP, TP-T; for Bofors 40 mm L/70 HE (M48); for M3 guns on M24 light tank 75 mm 76 mm

HE, TP, TP-T, Non-FRAG FLASH; for OTO Melara

76/62 naval gun

HE-T (M71A1), TP-T, HE (M71), TP; for M36, M41 and 90 mm

M54 tank guns

HE (M1), Smoke (M60), Illuminating (M314 series), 105 mm

Cargo HE 24G; for M52, M52A1, M101, M101A1, M108

and M102 howitzers

TP-7 (M467); for L7/M68 tank guns 105 mm

155 mm HE (M107), Illuminating (M485A2), cargo HE GR M49,

GR M49 ERBB, Smoke (M110A2 and M116A2 series);

for 155 mm howitzers

203 mm HE M106 for 203 mm (8 in howitzers) Propelling charges M119A1, M119A2, M3A1, M4A2; for 155 mm,

M2 8 in/203 mm

Fuzes PD M524A6, PD M557, PD M557 P1 with set back

PYRKAL has embarked on a long-scale development programme for Improved Conventional Munitions (ICM). One result of this programme has been the 4.2 in/107 mm GRM 20 mortar bomb carrying 20 submunitions, each containing 30 grams of Composition A5 explosive.

105 mm Howitzer HE/ICM Grenade Submunition Carrier Cartridge Type 24 G

This can be fired from 105 mm howitzers including the M49, M2A1, M2A2, M103, M137, L5, L14 and Model 56 Pack Howitzer. This improved conventional munition carries 24 grenades which are ejected over the target area at a height of 300 m and cover an area of 10 000m2. The grenades are called the M24 G and have a copper cone for the hollow charge action, 30 grams of composition A5 and a base detonating fuze GRM3A2.

SPECIFICATIONS

o. mon	
CALIBRE	105 mm
LENGTH	
complete (with fuze)	834 mm
projectile with fuze	489 mm
WEIGHT	
complete	19 kg
projectile	12 kg
Armour penetration	70 mm
Max range charge 7	11 000 m



PYRKAL 105 mm Howitzer, HE/ICM round Type 24 G

155 mm Howitzer HE/ICM Submunition Carrier Projectile Type GR M49

This projectile can be fired from 155 mm howitzers such as the M114A1, M114A2, M109A1 and M198. It consists of a main body comprising 49 grenades, the expulsion charge and expulsion plate, the inserts retaining the grenades in the correct position, the spaces and the base plug. The grenades are called GM1 and have a body of high fragmentation steel that contains approx 65 g of explosive. A copper cone is used for the hollow charge action and the grenade uses a base detonating fuze GRM3A2.

SPECIFICATIONS

CALIBRE	155 mm
LENGTH	
(projectile without fuze)	802 mm
Total (with fuze)	896 mm
WEIGHT (without fuze)	46 kg
MAX RANGE	22 400 m

155 mm Howitzer HE/ICM Extended Range Grenade Submunition Carrier Projectile GR M49 ERBB

This is a modified version of the GR M49 but fitted with a base bleed unit to extend its range. Using an M203 propelling charge and a 39 calibre ordnance, a range of 27 000 m can be achieved.

More conventional munitions under development include 105 mm tank gun ammunition (including APFSDS produced under licence). PYRKAL also produces the GM 40-82 anti-tank round for the RPG-7 rocket launcher.



Manufacturer: Greek Powder & Cartridge Company (PYRKAL), 1 Ilioupoleos Avenue, GR 172 36, Hymettus, Greece. Telephone: (1) 975 18 57 Telex: 221 986 EEPK GR

Fax: (1) 970 50 09

Note: Late in 1991 it was stated that proposals for merging PYRKAL and EBO had been accepted by the Greek Government. A new body will be formed linking the two companies with PYRKAL to be absorbed by EBO under a unified board.

PYRKAL 155 mm Howitzer, HE/ICM round Type GR M49

EBO Ammunition

Hellenic Arms Industry (EBO) SA was established in 1977 with the initial task of developing and manufacturing light infantry weapons for the Greek Armed Forces. Since then EBO has grown in size and diversity and, among a large range of defence products, now also manufactures ammunition.

Ammunition now in production or under development includes the following:

Artemis 30 mm × 173 Ammunition Family

There are currently four types of Artemis 30 mm × 173 ammunition with all rounds having a muzzle velocity of 1025 m/s and an overall length of 289 mm. The four types are HEI, HEI-T with PDSD fuze and TP, TP-T.



EBO 155 mm howitzer projectiles from left to right: M107, ERA and ERMIS with EBO propelling charges in background

30 mm Ammunition for Hispano-Suiza 831 L Gun

Four types of ammunition are produced for this weapon, HEI-SD, HEI-SD-T, TP and TP-T with each round having a muzzle velocity of 1080 m/s and an overall length of 285 mm.

90 mm and 105 mm Ammunition

EBO manufactures the HE-T M71A1 and the HE M71 for the 90 mm cannons M36, M41 and M54, the 105 mm HE M1 ammunition for howitzer cannons M2A1, M2A2, M49, M101, M102, M103, M53, M52A1, M108, M137 and the M456 HEAT-T for the M68 tank gun.

203 mm (8 in) Ammunition

EBO manufactures the M106 HE projectile for the 8 in (203 mm) howitzer cannons M2, M2A1, M47, M2A2, M115, M110, M110A1 and M110A2. The projectile weighs 92.53 kg and is 871 mm long.

155 mm Family of Ammunition

EBO has developed and produces the 155 mm family of ammunition ranging from the standard NATO conventional M107 HE projectile to the more recent ERMIS and ERA ammunition systems. EBO also manufactures a range of single base propelling charges for use with all types of projectile.

ERMIS (Extended Range Modified Integration System) or M107/BB can be supplied as a complete round or by modifying existing stock of 155 mm M107 projectiles.

The long range is achieved by a combination of the base bleed and the high performance single base propelling systems EBO 5 and EBO 6. When fired from a 39 calibre howitzer a range of 23.5 km can be achieved, or 26.1 km from a 45 calibre howitzer.

ERA (Extended Range Ammunition) is a concept utilising the aerodynamic shape of the projectile, the base bleed unit and the high performance of the propelling systems in order to attain long range with an increased payload.

ERA, when fired from a 39 calibre howitzer, can achieve a range of 27.4 km and 35.6 km when fired from a 45 calibre howitzer. In addition, there is also a 66 per cent increase in lethality due to the enlarged explosive

Type	M107 (HE)	ERMIS (HE)	ERA (HE)
WEIGHT	42.91 kg	47.2 kg	44.95 kg
TYPE OF FILLING	TNT	TNT	TNT
WEIGHT OF FILLING	6.1 kg	6.1 kg	8.8 kg
LENGTH (complete round)	687 mm	794 mm	850 mm

Range table for EBO 155 mm ammunition:

Howitzer	Projectile Propelling Charge	M107	ERMIS	ERA
39 cal*	EBO - 5	18 000 m	21 300 m	21 800 m
	EBO - 6	19 300 m	23 500 m	24 400 m
	EBO - 7	incompatible	incompatible	27 400 m
45 cal**	EBO - 5	17 800 m	20 700 m	21 100 m
	EBO - 6	18 000 m	22 600 m	23 600 m
	EBO - 7	20 400 m	24 800 m	26 200 m
	EBO - 8	21 400 m	26 100 m	27 900 m
	EBO - 9	incompatible	incompatible	35 600 m

^{*}includes M109A2/M109A3, M198, M-71, FH-70, FH-77 and M114/37

Manufacturer: Hellenic Arms Industry (EBO) SA, 160 Kifissias Avenue, Athens, Greece.

Telephone: 647 2611 Telex: 21 8562 EBO GR Fax: 647 2715

Note: Late in 1991 it was stated that proposals for merging PYRKAL and EBO had been accepted by the Greek Government. A new body will be formed linking the two companies with PYRKAL to be absorbed by EBO under a unified board.

INDIA

A new anti-tank ammunition facility has been established at Tiruchirappalli to produce 105 mm APFSDS ammunition for the L7 gun fitted to the Vijayanta (Vickers Mk 1 MBT). The facility cost Rs700 million.

Indian Ordnance Factories produce 40 mm HE rounds for the Bofors 40 mm L/70. It is anticipated that some types of the 155 mm howitzer ammunition supplied with the Bofors 155 mm FH-77B howitzers, ordered by India during 1986, will be manufactured under licence in India.

40 mm HE-T L/70 Round

A 40 mm HE-T round is manufactured for the 40 mm Bofors L/70 anti-aircraft gun and brief details of this are as follows:

CALIBRE	40 mm
LENGTH (overall)	534.4 mm
WEIGHT OF COMPLETE ROUND	960 g
MUZZLE VELOCITY	1000 m/s
MAX HORIZONTAL RANGE	12 600 m
TIME TO SELF DESTRUCT	8 s
SAFETY DISTANCE	50 m

105 mm APDS-T and 105 mm HESH Rounds

The 105 mm L7 series tank gun installed in the Vijayanta MBT fires APDS-T and HESH rounds produced in India.

The 105 mm APDS-T round consists of a brass cartridge case, electric primer L1A4, propellant and APDS-T projectile. The projectile is made of cored shot which consists of a tungsten carbide core with a steel cup and a nose of sintered tungsten alloy encased in a steel sheath. The sheath is in two parts, the front made of aluminium alloy and the rear of steel.

The HESH round consists of electric primer L1A4, brass cartridge case and the projectile itself. The projectile is made of alloy steel and is cylindrical in shape and fitted with two driving bands made of copper. The projectile is

secured in the mouth of the cartridge case by canneluring in between the two driving bands and by coning the mouth in the groove of the upper driving band.

SPECIFICATIONS		
Type	HESH	APDS-T
CALIBRE	105 mm	105 mm
MUZZLE VELOCITY	732 m/s	1478 m/s
RANGE	8000 m	3500 m
WEIGHT OF COMPLETE ROUND	21.12 kg	18.37 kg
LENGTH	939.8 mm	836.42 mm
PROPELLANT WEIGHT	2.92 kg	5.6 kg
PROPELLANT TYPE	NH 033	NQ/M 044
ACCURACY (horizontal and vertical)	within 1 mil standard deviation up to 1800 m	 within 0.8 mil standard deviation up to 1800 m
ARMOUR PENETRATION (at 914.38 m)	120 mm at 0° to 65° at all ranges	120 mm at 60°
WORKING PRESSURE TRACER	1894 kg/cm ² No 33 Mk I/II	4150 kg/cm ² No 33 Mk I

Other Ammunition

PRIMER

In addition to the previously mentioned ammunition types, India manufactures a wide range of other ammunition types including 125 mm for the T-72 MBT which is made under licence in India.

Electric L1A3

or L1A4

Electric L1A3

or L1A4

Manufacturer: Director (Exports), Department of Defence Production & Supplies, Ministry of Defence, New Delhi 110 011, India.

IRAN

Ammunition Production

In recent years Iran has made a major effort to become self-sufficient in ammunition of all types. It is known that ammunition is now being produced for the 100 mm D-10 gun installed in the T-55 MBT and the 120 mm gun installed in the Chieftain MBT.



^{**}includes GC 45 and GH N-45

IRAQ

Ammunition Production

Prior to the 1991 Middle East conflict, Iraq was self-sufficient in some types of ammunition. Listed below is a résumé of the large calibre types that they stated were in production in 1990. Following the intensive air campaign of early 1991 it is probable that much of their ammunition manufacturing capability has been destroyed.

210 mm ERFB-BB 155 mm ERFB-BT 155 mm ERFB-BT-BB 152 mm HE 130 mm HE 130 mm Illuminating 130 mm smoke 125 mm APFSDS 125 mm HE 122 mm cargo 122 mm illuminating 122 mm leaflet 122 mm smoke 115 mm HE 106 mm HE 106 mm HEAT 106 mm HESH 105 mm HE (semi-fixed)

100 mm HE



125 mm APFSDS and 125 mm HE projectiles for T-72 MBT manufactured

ISRAEL

TAAS - Israel Industries

TAAS - Israel Industries Ltd (previously Israel Military Industries) manufactures the following types of ammunition:

Type CALIBRE APPLICATION	HEAT 105 mm M60, Centurion and any AFV armed with L7/M68 gun	HE (M56) 155 mm 155 mm how, L33, M109, M109A1	HE (M107) 155 mm 155 mm how, L33, M109 M109A1	HE/RAP 155 mm 155 mm how, L33, M109 M109A1	ILL (M485A2) 155 mm 155 mm how, L33, M109 M109A1
WEIGHT	100000 T				5 × 40 × 50 × 50
complete round projectile content LENGTH	22 kg 10.25 kg 1 kg Comp B	n/app 43.5 kg 8.5 kg TNT	n/app 43 kg 6.6 kg TNT	n/app n/app 4.5 kg Comp B	n/app 40.5 kg 2.65 kg
complete round	999 mm	n/app	n/app	n/app	n/app
projectile MAX MUZZLE	647 mm	790 mm	700 mm	821 mm	700 mm
VELOCITY	1174 m/s	713 m/s	716 m/s	n/app	725 m/s
NOTES	Will penetrate 360 mm of armour at 30° incidence at 2500 m range, PIBD M509 fuze	Max range 19 870 m (from M109A1), fitted with PD M557, MTSQ M520 or M564, VT M514A1 or M728 fuze	Max range 19 050 m (from M109A1), fitted with same fuzes as M56 155 mm projectile	Max range 22 400 m, fitted with PD M577 or VT M514 fuzes	Max range 18 700 m

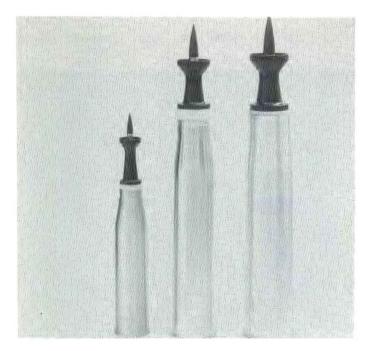
In addition to these, TAAS - Israel Industries produces a 130 mm HE shell for the former Soviet M-46 field gun. The shell is fitted with a PD M739 fuze. TAAS - Israel Industries also manufactures the US Cartridge 105 mm, HE, M1 for 105 mm howitzers, and the 155 mm, HC, smoke projectile M116A1 for M50, M109 and M109A1 howitzers and basic details of these are as follows:

Cartridge 105 mm, HE, M1

MAX MUZZLE VELOCITY

CALIBRE 105 mm WEIGHT complete 19 kg HE content (TNT) 1.93 kg fired 15 kg LENGTH with M739 fuze 494 mm cartridge case 372 mm **FUZES** M557 or M439 PROPELLANT CHARGE MAX RANGE 11 270 m (charge 7)

472 m/s



TAAS – Israel Industries APFSDS-T rounds. From left to right: 60 mm, 90 mm and 105 mm M111

155 mm, WP, Smoke Projectile M110A2

CALIBRE	155 mm
WEIGHT (fired)	44.3 kg
WEIGHT (filler WP)	6.4 kg
LENGTH (fired)	700 mm
MAX RANGE	19 050 m (M9A2 charge)
MAX MUZZLE VELOCITY	716 m/s (M9A2 charge)
FUZES-PD	M557 and M739
MTSQ	M520 and M564
VT	M728
Primers	

percussion Mk 2A4 with M50 ordnance percussion M82 with L33, M109 and M109A1

155 mm, HC, Smoke Projectile, M116A1

CALIBRE	155 mm
WEIGHT (fired)	43 kg
Filler, HC	8.7 kg
LENGTH (fired)	700 mm
FUZE	M565 MT

MAX RANGE 19 050 m (M9A2 charge) MAX MUZZLE VELOCITY 716 m/s (M9A2 charge)

APFSDS Ammunition

The company now manufactures APFSDS ammunition in three calibres, 60 mm, 90 mm and 105 mm. The 60 mm round is used on the HVMS weapon system and there is currently a 60 mm HE round under development to complement this projectile. The 60 mm HE round is 640 mm long, weighs 7.2 kg and the projectile weight is 2.9 kg. No other details are available.

The 90 mm round is for use with the 90 mm guns fitted to M47 and M48 tanks. The 105 mm projectile is now well established and has been referred to as the M111. It is already in service with the Israeli, German (where it is known as the DM23), Danish, Swedish and Swiss Armies. This design is licence produced in Germany (by Diehl) and in Switzerland.



TAAS – Israel Industries 130 mm HE shell for M-46 field gun (Christopher F Foss)

Calibre	60 mm	90 mm	105 mm
WEIGHT complete round	6 ka	13.5 kg	18.7 kg
projectile	1.35 kg	4 kg	6.3 kg
penetrator	0.87 kg	2.6 kg	n/a
LENGTH			
round	620 mm	860 mm	885 mm
projectile	294 mm	385 mm	417 mm
DIAMETER (penetrator)	17 mm	35 mm	30 mm
MUZZLE VELOCITY	1620 m/s	1430 m/s	1455 m/s
PENETRATION (60° armour plate)			
depth/range	120 mm/	120 mm/	150 mm/
	2000 m	3000 m	2000 m

105 mm M413 APFSDS-T

This is the latest second generation APFSDS-T and can be fired from L7, M68 and F1 guns without modifications.

The complete round consists of a cartridge case containing approximately 5.8 kg of propellant and a projectile consisting of a three segment sabot with obturator rings and the sub-projectile, with a tungsten alloy penetrator. The cartridge case contains a titanium oxide bore wear-reducing liner. The sub-projectile is fin-stabilised and made of tungsten alloy and is effective against both NATO Heavy Single Target (NHS) and NATO Heavy Triple Target (NHT) at ranges over 6000 m.

SPECIFICATIONS

CALIBRE	105 mm
WEIGHT	18.7 kg
projectile	6.3 kg
propellant	5.8 kg
LENGTH	990 mm
projectile	592 mm
MUZZLE VELOCITY	
(L7/M68)	1455 m/s
(F1)	1495 m/s
TRACER BURN TIME	4.5 s
MAX EFFECTIVE	
RANGE	6000 m
ACCURACY	
typical standard	
deviation vertical	0.2%
typical standard	
deviation horizontal	0.2%

120 mm Tank Ammunition

The new Merkava Mk 3 has a 120 mm smooth-bore gun developed by TAAS – Israel Industries that fires their APFSDS and HEAT ammunition, but no firm details of this have so far been released.

140 mm APFSDS-T Tank Ammunition

Late in 1992, TAAS – Israel Industries revealed that it was working on a 140 mm APFSDS-T round to be fired from a 140 mm smooth-bore tank gun.

No technical details were released although it is estimated that the tungsten rod penetrator has a length-to-diameter ratio of about 25 to 1. The three part sabot has a plastic driving band on the rear with the penetrator having eight fins.

The Merkava Mk 1 and 2 are both armed with a 105 mm rifled tank gun while the more recent Mk 3 is armed with a new 120 mm smooth-bore gun developed by TAAS – Israel Industries.

It is known that a new version of the Merkava MBT is currently under advanced development and may well already be at the prototype stage. This will probably be armed with a 140 mm smooth-bore gun and called the Merkava Mk 4.

155 mm Cargo Rounds

The company has developed and placed in production two basic types of 155 mm cargo projectile that can be fired with all charges from howitzers such as the towed FH-70 and M198 and the self-propelled M109A1 series.

One projectile is the CL 3109 which carries 63 CL 3022-S2 dual purpose grenades to a maximum range of 22 400 m. Depending on the firing parameters, the grenade dispersion radius is of the order of 70 m. The CL 3022-S2 grenade has two independent safety mechanisms as well as an additional pre-assembly safety device. Also included are a unique anti-spin device and a mechanical arming delay for the mechanical impact fuze. Each grenade has an external diameter of 55.65 mm and weighs 305 g of which 170 g is produced as controlled fragments by the RDX-based explosive filling.

The second projectile, the CL 3013, is available in two versions: the CL 3013-C with a maximum range of 28 750 m and the CL 3013-U with a maximum range of 30 000 m. Both models are of the low drag type with base bleed to achieve the longer range and use identical parts with the exception of the ogive. Both carry 49 CL 3022-S2 grenades.

Under a contract approved late in 1988, Switzerland purchased \$130 million worth of 155 mm cargo rounds from Israel. This followed trials between the then Israel Military Industries cargo round and a United States cargo round.

SPECIFICATIONS			
Model	CL 3109	CL 3013-C	CL 3013-U
WEIGHT	47 kg	42 kg	42.7 kg
LENGTH (with fuze)	898 mm	900 mm	952 mm
MAX VELOCITY	797 m/s	850 m/s	846 m/s
MAX RANGE	22 400 m	28 750 m	30 000 m
TYPICAL RANGE			
PRECISION	0.35%	0.35%	0.35%
MAX CHAMBER			
PRESSURE	4158 bar	4158 bar	4158 bar
PAYLOAD	63 grenades	49 grenades	49 grenades

105 mm, 175 mm and 203 mm Cargo Rounds

In addition to the 155 mm cargo rounds previously described, TAAS -Israel Industries has also developed 105 mm, 175 mm and 203 mm (8 in) cargo rounds and brief details of these are given below:

Model	CL 3131	CL 3014	CL 3046
CALIBRE	105 mm	175 mm	203 mm
LENGTH	621 mm	1066 mm	1115 mm
WEIGHT	15 kg	61.1 kg	93.5 kg
NUMBER OF GRENADES	15	81	120
GRENADE DISPERSION			
AT MAX CHARGE			
(diameter)	100 m	150 m	178 m
MAX RANGE	10 800 m	30 000 m	23 400 m

In addition, TAAS - Israel Industries is also developing a 120 mm mortar projectile called the CL 3144 which will carry 24 grenades. These grenades are also carried in the ATAP 500 and ATAP 1000 aircraft bombs and the 160 mm light artillery rocket.

Bantam Dual Purpose Grenade

All of the TAAS - Israel Industries cargo rounds and bombs use the CL 3022-SD Bantam dual purpose grenade. This is one of the shaped charge type and features a self-destruct fuze, impact fuze that functions at steeper angles of impact and at lower impact velocities, and high penetration due to an anti-spin device which reduces rotation on impact to almost zero. A handling safety mechanism renders the accidental arming of unarmed duds by manual manipulation impossible.

SPECIFICATIONS

OUTSIDE DIAMETER 42 mm PACKAGING LENGTH 55.65 mm TYPE OF EXPLOSIVE RDX with binder WEIGHT (of explosive) 44 g (approx) TYPE (of fragmentation) controlled TYPE (of fuze) mechanical impact

with pyrotechnic self-destruct mode



From left to right TAAS - Israel Industries cargo rounds 203 mm CL 3046. 155 mm CL 3013-C and 155 mm CL 3109

PENETRATION (into RHA at built in stand-off) 105 mm Average fragment effectiveness 2 fragments/m² for grenade defined as perforation up to distance of 9 m of 1.5 mm mild steel plate

Manufacturer: TAAS - Israel Industries, PO Box 1044, Ramat Hasharon 47100, Israel.

Telephone: (3) 48 92 22 Telex: 33 719 Fax: (03) 540 6908

Soltam Ammunition

In addition to its artillery production activities, Soltam Limited also produces a range of 155 mm howitzer ammunition. Details are as follows:

Type CALIBRE WEIGHT LENGTH FILLING HE		M107A1 HE 155 mm 42.3 kg 602 mm TNT	M56 HE 155 mm 42.75 kg 690 mm TNT	M56A1 HE 155 mm 42.75 kg 690 mm TNT	M953 HE 155 mm 43.6 kg 869 mm TNT	Training 155 mm 34 kg 602 mm none ¹
WEIGHT RANGE 39-cal	6.6 kg	6.6 kg	8.8 kg	8.8 kg	9.2 kg	_
Zone 9 39-cal	19 045 m	19 045 m	19 045 m	19 870 m	20 800 m	3000 m
Zone 10 45-cal	_	21 900 m	23 400 m	23 480 m	25 000 m	-
Zone 11	-	_	-	25 800 m	27 500 m	_

^{&#}x27;No filling but smoke signal optional

Manufacturer: Soltam Limited, POB 1371, Haifa, Israel. Telephone: (4) 89 62 11 Telex: 46277 Fax: (4) 89 40 20



Soltam 155 mm projectiles, from left: M953 HE, M56 HE and M107 HE

ITALY

BPD Ammunition

BPD has several fully integrated facilities for the production of a wide range of ammunition, as well as extensive research and development facilities. A resume of ammunition currently produced by the company follows:

27 mm for Mauser cannon used on Tornado MRCA aircraft

40 mm BL, BL-T, HE-PFF, APC-T, HE-HPF and HEI, HEI-T for L/70 Bofors Breda guns

76/62 76 mm for OTO Melara guns, HE, HE-HPF, HE-PFF, HE-AP, TP, TP-T, FNF, PFF (IM 84) top performance rounds are also available 90 mm HE (American M71) and smoke WP (American M313) for M47 and

M48 tanks, and 90 mm M117 and M118 anti-aircraft guns. 90 mm APC-T M82, HEAT-T (M431) for M47 and M48 tanks, 90 mm blank

105 mm HE (American M1), HE-RAP, HEAT-T (American M67), illuminating (American M314A2), smoke WP (American M60) Blank and smoke HC (American M84) for 105 mm M101 and M102, OTO Melara Model 56 pack howitzer and M7, M52 and M108 self-propelled howitzers

105 mm HEAT-T (American M456A1) for Leopard 1 and M60 tanks and other AFVs armed with L7 or M68 rifled tank guns. Also 105 mm HEAT-T-MP, APFSDS-T and TP-T

155 mm HE (American M107), illuminating (American M118A2), smoke BE (American M116), smoke WP (American M110) for M114 towed howitzer, M44 and M109 self-propelled howitzers, FH-70, M198

155 mm long-range (base bleed) IM 280, cargo round (anti-personnel and anti-material bomblets) IM 303 which have been developed by BPD Difensa Espazio and are covered in detail below

175 mm HE (American M437A1) for M107 self-propelled gun

203 mm HE (American M106) for M110 self-propelled howtizer and M115 towed howitzer

105 mm Tank Ammunition

All of these have a brass cartridge case with an electric primer.

SPECIFICATIONS

Model	APFSDS-T	HEAT-T	TP-T	HEAT-T-MP	
WEIGHT OF ROUND	19 kg	21.8 kg	21.8 kg	21.6 kg	
WEIGHT OF PROPELLANT	5.2 kg	5.2 kg	5.2 kg	5 ka	

155 mm IM 280 BDR

The 155 mm FH-70 fires a conventional projectile to a range of 24 000 m, but the IM 280 BDR fitted with a base bleed unit has a maximum range of 32 000 m.

SPECIFICATIONS

MIDDE

CALIDAE	199 11111
RANGE	32 000 m
MUZZLE VELOCITY	820 m/s
PROPELLANT TYPE	composite
WEIGHT	
(total projectile)	44.5 kg
HE content	10.7 kg
Propellant	1 kg
LENGTH (with fuze)	891 mm
TEMPERATURE RANGE	-46 to +63°C

155 mm IM 303 cargo round

This is the Italian designation for the German RB 63 round which is a joint development between Rheinmetall of Germany and BPD Difesa Espazio of Italy. The bomblets are heavier and larger than the M42/M46 and are supplied with an aerodynamic brake that reduces the spin, in comparision with the standard one, and so produces a higher penetration against hard targets. It also has a higher number of fragments with increased energy and an improved fuze giving a higher probability of functioning against hard and semi-hard targets.

1 E E mm

SPECIFICATIONS

CALIBRE	155 mm
MAX RANGE	23 000 m (charge 8, FH-70)
WEIGHT	47 kg
LENGTH (with fuze)	899 mm
Fuze	FB 388 or M577
LONGITUDINAL DISPERSION	0.3%
LATERAL DISPERSION	1 mil
MAX PRESSURE	4200 bar
TEMPERATURE LIMITS	-46 to +63°C
PAYLOAD	63 bomblets

BOMBLET SPECIFICATIONS

WEIGHT	330 g
DIAMETER	42 mm
LENGTH (complete)	90 mm
Packing	55 mm

Manufacturer: BPD Difesa Espazio, Settore Difesa e Spazio, Corso Garibaldi 22, I-00034 Colleferro (Rome), Italy. Telephone: (6) 97 29 1 Telex: 611 114

SIMMEL DIFESA Artillery Ammunition

SIMMEL DIFESA has two facilities engaged in the production of ammunition. Castelfranco Veneto produces the metal parts such as the projectile body and Castagnole di Paese does the filling, assembly and packaging of the entire range of ammunition. Types of projectile manufactured by Simmel include 105 mm smoke HC or coloured, illuminating (American M314A2) and smoke WP (American M60). 155 mm projectiles include HE (American M101 and M107), HE high capacity (for International FH-70), smoke WP, smoke HC or coloured, and illuminating (American M118A2). Other projectiles include 175 mm HE (American M437A1) and 203 mm HE (American M106). The company is able to supply complete rounds (loaded projectile, propelling charge and fuze), or separate parts such as the projectile body, propelling charges and pyrotechnic elements.

Simmel is now specialising in illuminating ammunition. A 155 mm illuminating canister is qualified by the Tri-partite Nations for use in the FH-70 illuminating projectile and the new 155 mm projectile carrier is patented by Simmel.

155 mm Ammunition for Palmaria

Simmel has developed five new projectiles specifically for use with the OTO Melara 155 mm self-propelled howitzer, the Palmaria. These projectiles can also be used with other long barrel 155 mm howitzers such as the FH-70 and the M109 series.

There are two basic systems of propelling charges for all the Simmel 155 mm projectiles. The first system includes charges 1 to 5, and the second consists of a single charge 6.

HE Ammunition

This ammunition includes three projectiles, the P3 HE, the P3 HE LT and the P3 HE RAP. The P3 HE is made of special steel which strengthens the projectile walls enough to make them thinner than the norm so that an increased explosive payload can be used. This gives an explosive and steel ratio of 1:3 instead of the more usual 1:5. The explosive charge consists of an RDX/TNT mixture.

The 'Long Trajectory' version of P3 HE projectile has been developed to increase the range of this projectile without affecting the terminal effectiveness. In this type the base drag coefficient is further reduced by a completely original device. The range increase is an average of 15 per cent in comparison to the P3 HE.

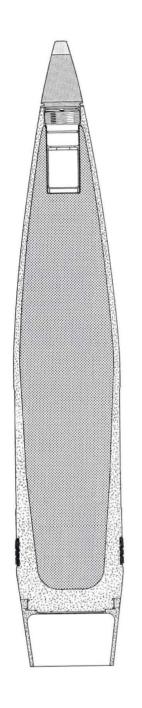
The P3 HE RAP projectile uses a solid propellant motor to increase the range of the projectile by as much as 25 per cent over the norm. The motor is at the base of the projectile body and consists of 2.8 kg of propellant grain in a high resistance special steel body screwed onto the base of the warhead. The weight and size of the motor reduces the size of the warhead from the usual 11.7 kg to about 8 kg.

Type	P3 HE	P3 HE LT	P3 RAP
LENGTH			
(with fuze, total)	933 mm	933 mm	933 mm
WEIGHT			
(with fuze, total)	43.5 kg	43.5 kg	43.5 kg
RANGE			
(max, with charge 6)	24 000 m	27 500 m	30 000 m
INCREASE IN RANGE	_	15%	25%
EXPLOSIVE CHARGE			
WEIGHT	11.7 kg	11.7 kg	8 kg
PROPELLANT			
WEIGHT	-	1 kg	2.8 kg
TEMPERATURE	40		
LIMITS	-40 to +60°C	−40 to +60°C	−40 to +60°C

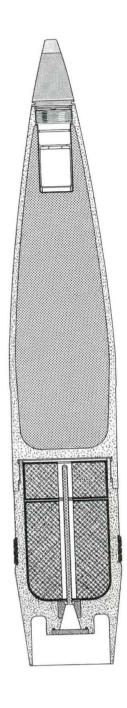
Illuminating

The projectile used for the illuminating role is the P4 which is of the base ejection type. It has a conventional carrier body of high resistance steel with the base closed by a base plug secured by twist pins. The body of the projectile has been designed to follow the external and internal ballistics of the P3 projectiles as closely as possible, to allow the use of the same range tables and charge system.









SIMMEL DIFESA 155 mm P3 HE projectile

SIMMEL DIFESA 155 mm P3 HE RAP projectile

LENGTH (with fuze) WEIGHT (with fuze, total) SEPARATING VELOCITY (max) **FUZE TYPE FUZE SETTING RANGE** TEMPERATURE LIMITS RANGE (max, with charge 6) ILLUMINATING PERFORMANCE I, mean Burning time (min) Descending speed (max)

Illumination on 800 m diameter area

933 mm 43.5 kg 340 m/s mechanical time 5-100 s -40 to +60°C 24 000 m

 $2 \times 10^6 \text{ cd}$ 65 s 5 m/s 5 lux

The P5 smoke projectile follows the same general body construction as the P4. The cavity of the body holds four smoke canisters.

LENGTH (with fuze) 933 mm WEIGHT (with fuze, total 43.5 kg SEPARATING VELOCITY (max) 340 m/s

FUZE TYPE FUZE SETTING RANGE TEMPERATURE LIMITS RANGE (max, with charge 6) SMOKE SCREENING DATA Weight of smoke composition Burning time (min) Smoke screening effect (1 canister) total extension height at 150 m from burst width Environmental reference conditions wind speed temperature gradient relative humidity

mechanical time 5-100 s -40 to +60°C 24 000 m 7.9 kg

2.5 mins 200 m 10-15 m 50 m

5 m/s normal 90% +10°C temperature on open terrain

Manufacturer: SIMMEL DIFESA SpA, Borgo Padova 2, Castelfranco

Veneto, I-31033 Treviso, Italy.

Telephone: (423) 4251 Telex: 410127 SIMMEL I

Fax: (423) 496899/425334

ERBER 105 mm HE EM 20 Carrier Round

ERBER has developed a 105 mm carrier round known as the HE EM 20 containing 20 M42 submunitions. The submunitions are carried inside the shell body in five layers of four submunitions and are dispensed through the shell base by a black powder charge under the control of the nose-mounted time fuze. Each M42 submunition is a cylinder 38.1 mm in diameter and weighing 30.5 grams. The impact-fuzed explosive charge is Comp A5 which can penetrate up to 70 mm of steel armour plate.

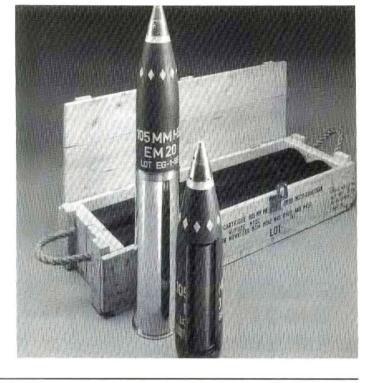
The projectile can spread its contents over a radius of between 100 and 250 m and can be fired using Charge 7 to a range of 11 500 m from most 105 mm howitzer barrels. Weight of the complete round is 19 kg and the total length is 790 mm.

Late in 1988 it was stated that ERBER was developing a 203 mm (8 in) base bleed cargo round for the M110 series of self-propelled howitzers which would have a maximum range of over 30 000 m. This is being developed as a private venture with no firm Italian Army requirement.

Status: Development complete. Ready for production.

Manufacturer: ERBER; Regione Pianetto 12, I-10070 Grosso CSe, Turin, Italy

Telephone: (11) 929 62 96 Telex: 210 035 Fax: (11) 929 70 42



ERBER 105 mm HE EM 20 carrier round

Europa Metalli - LMI

Europa Metalli - LMI Spa is primarily known for the manufacture of small arms ammunition, semi-finished products required for the manufacture of cartridges and cartridge cases, percussion primers, ammunition belts, links and clips, and cartridge cases for a variety of ammunition up to 127 mm in calibre. The 20 mm ammunition manufactured by the company includes

API, HEI and TP for the Vulcan aircraft cannon and AP-T and TP for 20 mm Hispano-Suiza and Oerlikon cannon.

Manufacturer: Europa Metalli - LMI Spa, Borgo Pinti, 99, I-50121 Florence.

Telephone: (055) 49741 Telex: 571598 SMI FL L

76 mm OTO Melara Ammunition

This range of 76 mm ammunition was originally developed by OTO Melara for use with the 76 mm OTO Melara Compact naval gun system which is used by many countries.

Main armament of the private venture OTO Melara 76 mm self-propelled OTOMATIC air defence tank is a 76 mm 62 calibre automatic gun with a vertical sliding breech-block and machanical firing. This gun is derived from the 76 mm OTO Melara Super Rapid naval gun system with cyclic rate of fire increased to 120 rds/min.

This gun uses ammunition developed for the naval application including the PFF prefragmented anti-aircraft round with proximity fuze and the MOM multi-role round with VT, PD and time delay fuzing.

An APFSDS-T round has been specifically developed for the OTOMATIC to enable the system to engage ground targets. This will penetrate 150 mm of armour at 60° NATO incidence at a range of 2000 m.

In the future, OTO Melara will integrate into the system the 76 mm course-correction shell which it is developing in association with British Aerospace Dynamics as a private venture.

By late 1992, extensive firing trials of the OTOMATIC self-propelled air defence tank had been completed but production had yet to start as no firm orders had been placed.

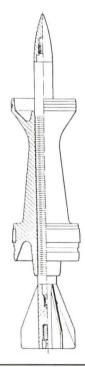
SPECIFICATIONS

Type	PFF	MOM	APFSDS-T
LENGTH projectile	355 mm	355 mm	421 mm
WEIGHT			
complete round	12.2 kg	12.25 kg	9.1 kg
projectile	6.3 kg	6.35 kg	2.175 kg
projectile charge	0.73 kg	0.75 kg	none

Status: With the exception of the APFSDS and course corrected shell, all members of the 76 mm family are currently in production.

Manufacturer: OTO Melara SpA, via Valdilocchi 15, 19136 La Spezia, Italy.

Telephone: (39 187) 581111 Telex: 270 0368 OTO | Fax: (38 187) 582669



Cutaway drawing of OTO Melara 76 mm APFSDS-T projectile

JAPAN

Japanese Tank Ammunition

For use by the Type 74 main battle tanks in service with the Japanese Self-Defence Force, Daikin Industry is now producing under licence the American 105 mm M735 APFSDS-T tank round. Daikin has developed a 120 mm APFSDS round for the new Japanese Type 90 main battle tank, and a new

HEAT-FS round for the same 120 mm gun has been developed by Komatsu Machinery. In June 1985 it was announced that the Type 90 was to have the Rheinmetall 120 mm gun so it is assumed that Rheinmetall ammunition

KOREA, SOUTH

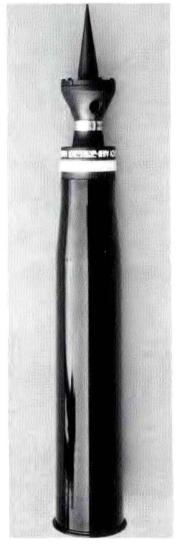
40 mm

BL-T

Poongsan Metal Corporation Ammunition

The Poongsan Metal Corporation is based in Seoul and manufactures a wide range of ammunition from small arms calibres to 8 inches. The range includes cannon, mortar, recoilless rifle, tank gun and artillery ammunition and nearly all are licence-produced American designs. Packing follows normal American practice and is fully compatible with American-produced weapons. Currently available are the following types:





105 mm APFSDS-T K270 round (right) and unfuzed 155 mm HERA M549A1 projectile (left), both produced by Poongsan Metal Corporation

Cannoi	n Ammunition			
Calibre	Type	Propellant	Fuze	Weapon use
20 mm	HEI-T-SD M246	WC 870	M505A3	M167
20 mm	HEI M56A3	WC 870	M505A3	M167, M39, M61
20 mm	TP-T M220	WC 870	n/a	M167, M39, M61
20 mm	TP M55A2	WC 870	n/a	M167, M39, M61
30 mm	HEI-T 831L UIAT	single base	KZC-L3	Oerlikon KCB-B
30 mm	HEI 831L UIA	single base	KZC-L3	Oerlikon KCB-B
30 mm	TP-T 831L ET	single base	n/a	Oerlikon KCB-B
35 mm	HEI-T PMD 020	single base	KED 242	Oerlikon GDF/353MK
35 mm	TP-T PMD 034	single base	n/a	Oerlikon GDF/353MK
40 mm	Anti-aircraft G	iun Ammur	nition	
Calibre	Туре	Propellant	Fuze	Weapon use
40 mm	TP-T M19	single base	n/a	Bofors L/60
40 mm	HEI-T MK11	single base	MK27	Bofors L/60
40 mm	PFHE MK2	single base	Prox	Bofors L/70
40 mm	APC-T	single base	n/a	Bofors L/70
40 mm	HEI-T	single base	Fz 104	Bofors L/70

Calibre	Type	Propellant	Fuze	Weapon use
90 mm	HE KM71	M15	KM557	M36, M41, M54
90 mm	TP-T KM353A2	M30	n/a	M36, M41, M54
90 mm	HEAT-T M431A2	M30	M509A1	M36, M41, M54
90 mm	APFSDS-T K241	M30	n/a	M36, M41, M54
105 mm	HEAT-T M456A1	M30	M509A1	L7, M68
105 mm	APFSDS-T K270	M30	n/a	L7, M68
105 mm	TP-T K490	M30	M509A1	L7, M68
105 mm	HEAT-MP-T	M30	KM509A2	L7, M68
	KM456A2			

single base

Bofors L/70

Calibre	Type	Propellant	Fuze	Weapon use
90 mm	HEAT M371A1	M82	M530A1	M67
90 mm	HE K242	KM82	K512	M67
106 mm	HEAT M344A1	M26	M509A1	M40A1

Calibre	Type	Propellant	Fuze	Weapon use
105 mm	HE M1	M67	M557	M2A1, M2A2, M49
105 mm	ICM M444E1	M67	M565	M2A1, M2A2, M49
105 mm	ILL M314A3	M67	M565	M2A1, M2A2, M49
155 mm	HE M107	M3A1, M4A2	M557,	M1, M1A1, M45.
			M564	M126A1, M185
155 mm	HERA M549A1	M4A2, M119,	M557,	M126A1, M185,
		M203	M564	M198
203 mm	HE M106	M1, M2	M557,	M2, M2A1
			M564	

Manufacturer: Poongsan Metal Corporation, Keuk Dong Building, 60-1, 3 Ka Chungmu-Ro, Chung-Ku, CPO Box 3537, Seoul, South Korea.

Daewoo Corporation Ammunition

The Daewoo Corporation produces a range of ammunition for anti-aircraft guns, anti-armour weapons, tank guns and artillery howitzers. The range of ammunition produced includes the following:

Anti-aircraft Gun Ammunition

Calibre	Type	Propellant	Fuze	Weapon use
20 mm	HEI	WC 870	n/a	M167A1, M39, M61
20 mm	HEIT-SD	WC 870	n/a	M167A1, M39, M61
20 mm	TP-T	WC 870	none	M167A1, M39, M61
20 mm	TP	WC 870	none	M167A1, M39, M61
30 mm	HEI-T	single base	K2C L3	Oerlikon AA guns
30 mm	HEI	single base	K2C L3	Oerlikon AA guns
30 mm	TP-T	single base	dummy	Oerlikon AA guns
35 mm	HEI	single base	KZD242	Oerlikon AA guns
35 mm	TP-T	single base	dummy	Oerlikon AA guns

Recoilless Rifle Ammunition

Calibre	Туре	Propellant	Fuze	Weapon use
90 mm	HEAT M371A1	M82	M530A1	M67
106 mm	HEAT M344A1	M26	M509A1	M40A2

Tank Gun Ammunition

Calibre	Туре	Propellant	Fuze	Weapon use
90 mm	HEAT-T M431A2	M30	M509A1	M36, M41, M54
90 mm	APFSDS-T K241	M30	none	M36, M41, M54
105 mm	HEAT M456A1	M30	M509A1	M68/L7
105 mm	APFSDS-T K270	M30	none	M68/L7

Howitzer Ammunition

Calibre	Туре	Propellant	Fuze	Weapon use
105 mm	HE M1	M67	M557	M101, M102, M108
105 mm	Smoke WP M60	M67	M557	M101, M102, M108
105 mm	III M314A1	M67	M557	M101, M102, M108
105 mm	DP-ICM PS390	M67	M557	M101, M102, M108
155 mm	HE M107	M3A1, M4A2	M557	M114, M109, M198
155 mm	Smoke WP M110A2	M3A1, M4A2	M557	M114, M109, M198
155 mm	RAP M549	M3A1, M4A2	M557	M114, M109, M198
155 mm	DP-ICM PS491	M3A1, M4A2	M557	M114, M109, M198
203 mm	HE M106	M1, M2	M557	M2, M110

Manufacturer: Daewoo Corporation, 541, 5-Ga, Namdaemoon-Ro, Jung-gu, CPO Box 2810, Seoul, South Korea.

Korea Explosive Group

This company was established in 1952 and currently manufactures explosives, propellants, ammunition, grenades, mines, signal devices, demolition charges, fuzes and other components for ammunition. International marketing is carried out by the Golden Bell Company Ltd. Listed below is a *résumé* of their ammunition types, excluding mortar bombs.

Calibre	Туре	Propellant	Fuze	Weapon use
90 mm	HEAT-T M431A2	M30	PI BD	tank guns
			M509A1	
90 mm	HEAT M371A1	M82	PI BD	recoilless
			M530A1	rifles
105 mm	HE M1	M67	PD M557,	howitzers
			MTSQ M564.	
			Prox M728	
105 mm	ILL M314A3	M67	MT M565	howitzers

Calibre	Туре	Propellant	Fuze	Weapon use
105 mm	HEAT-T M456A1	M30	PI BD M509A1	tank guns
106 mm	HEAT M344A1	M26	PI BD	recoilless
455	UE 14407		M509A1	rifles
155 mm	HE M107	n/a	PD M557, MTSQ M564,	howitzers
			Prox M728	
155 mm	ILL M485A2	n/a	MT M565	howitzers
155 mm	M549 HERA	n/a	PD M557,	howitzers
			Prox M732	
203 mm	M106 HE	n/a	various	howitzers

Manufacturer: Korea Explosives Company Ltd.

Exporter: Golden Bell Company Ltd, 14th Floor, Hyunam Building, 1, Changkyo-Dong, Chung-Ku, Seoul, South Korea.
Telephone: (82) 02 729 3791 Telex: K27453, K22935 KOMITE Fax: (82) 02 729 3535

Application

NETHERLANDS

Calibre

Type

Eurometaal

Eurometaal was established in 1973 as the successor of the 300 year old Artillerie-Inrichtingen, the former state-owned arsenal. In addition to a main factory at Zaandam there is a special filling, assembling and renovating plant for large calibre ammunition at Liebenau in Germany.

Eurometaal's production range consists of medium calibre ammunition (12.7 to 40 mm), tank ammunition and artillery ammunition (105 to 203 mm), large cartridge cases and pyrotechnical products such as smoke and illuminating shells, hand grenades, mines, tracers and igniters; in addition, extended range, improved armour-piercing and training ammunition is produced. The company also has its own research and development department, which has designed a new 12.7 mm (0.50) APHC projectile which is completely compatible with the existing 12.7 mm ammunition. The following types of ammunition are manufactured by Eurometaal:

Calibre 12.7 mm 12.7 mm 12.7 mm	Type Ball Dim Tracer API 2000	Application functionally equivalent to US M33 Eurometaal development new development, will penetrate 40.2 mm of RHA at a range of 100 m
12.7 mm	AP	functionally equivalent to US M2, will penetrate 22 mm of armour at 91.44 m range
12.7 mm	API	functionally equivalent to US M8, will penetrate 22 mm of armour at 91.44 m range
12.7 mm	API-T	functionally equivalent to US M20, will penetrate 22 mm of armour at 91.44 m range
12.7 mm	APHC	Eurometaal development, will penetrate 10 mm of armour at 45° incidence at 800 m range
12.7 mm	APHCI	Eurometaal development, will penetrate 10 mm of armour at 45° incidence at 800 m range
25 mm	API-T*	Oerlikon cannon (as installed in Dutch C & R vehicle and IFV)
25 mm	TPT*	Oerlikon cannon (as installed in Dutch C & R vehicle and IFV)

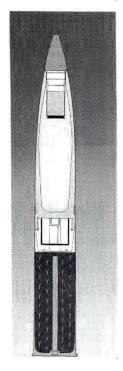
35 11111	APHE	for Gerlikon cannon
35 mm	HEI-T*	Oerlikon cannon (as installed in Gepard/
		Caesar SPAAGs)
35 mm	TP-T*	Oerlikon cannon (as installed in Gepard/
		Caesar SPAAGs)
40 mm	TP-T	for Bofors L/60
40 mm	HE	for Bofors L/60
40 mm	TP-T	for Bofors L/70
40 mm	HE	for Bofors L/70
90 mm	TPT	equivalent to M353A1, for tank guns
105 mm	ERM1-HE BBU	
105 mm	HE	equivalent to M1, for 105 mm howitzers
105 mm	Smoke WP	for 105 mm howitzers
105 mm	Smoke BE	for 105 mm howitzers
105 mm	APDS*	for L7/M68 series tank guns
105 mm	APFSDS-T	for L7/M68 tank guns
105 mm	DS-T*	for L7/M68 tank guns
105 mm	HESH*	for L7/M68 tank guns
105 mm	SH-Prac	for L7/M68 tank guns, Eurometaal
		development
105 mm	HE*	for AMX-13 with French tank gun
120 mm	APFSDS*	for Leopard II
155 mm	HE	equivalent to M107, for howitzers
155 mm	Smoke WP	equivalent to American WP, for howitzers
155 mm	Smoke BE	equivalent to American BE, for howitzers
155 mm	Illum	equivalent to M485 (modified), for howitzers
155 mm	M483A1*	cargo round USA-type
175 mm	HE	equivalent to M437
203 mm	HE	equivalent to M106

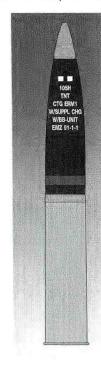
Propelling charges for 155, 175 and 203 mm howitzers. Several types of naval ammunition.

^{*} Under licence

105 mm ERM1-HE BBU

In 1992, Eurometaal announced that it had developed, as a private venture, a new extended range of 105 mm projectile called the ERM1-HE Base Bleed Unit (BBU). By late 1992 this had completed trials in Europe and the Far East and was ready to enter production on receipt of firm orders.





Cutaway drawing of Eurometaal 105 mm ERM1-HE BBU

Eurometaal 105 mm ERM1-HE BBU (complete round)

The 105 mm ERM1-HE BBU can be fired from the 105 mm M101, M102, Abbot, RDM upgraded M101/33 calibre, L119 Light Gun and Light Gun 105 (37 calibre barrel) and offers a significant increase in range over the HE M1 round which was developed over 50 years ago.

It can be fitted with point detonating fuzes M572C1 and M739A1, proximity fuzes NINA 169 and PPD 440 and time fuze MTSQ M582. Propelling charges used include M67 zones 4, 5, 6 and 7, M200 zone 8 and Super 9 zone 9. Eurometaal claim an accuracy of less than 0.40 per cent of range.

SPECIFICATIONS	
CALIBRE	105 mm
LENGTH (fuzed)	569 mm
WEIGHT	14.30 kg
WEIGHT	
of explosive content	2.20 kg
MAX RANGE	
23 cal gun, M67	
zone 7	12 700 m
23 cal gun, M200	
zone 8	16 750 m
33/37 cal gun, M67	
zone 7	13 900 m
33/37 cal gun M200	
zone 8	18 100 m
33/37 cal gun, Super	
zone 9	19 700 m

ERFB 155 mm Projectiles

In addition to the previous 155 mm projectiles, Eurometaal also manufactures 155 mm Extended Range Full Bore (ERFB) and 155 mm Extended Range Full Bore and Base Bleed Unit (BBU). Full details of these are given below. The extended range full bore cargo and base bleed units are also available from Eurometaal.

SPECIFICATIONS Type Length (fuzed) Weight explosive Weight of explosive Max Range 45 calibre		
ERFB-HE 938 mm 45.3 kg 8.2 kg Comp B 8.6 kg TNT 30 000 m 25 900 m ERFB-HE-BB 958 mm 47.6 kg 8.2 kg Comp B 8.2 kg Comp B 8.6 kg TNT 39 600 m 32 500 m ERFB-III 938 mm 45.5 kg n/a 30 000 m 29 500 m ERFB-III-BB 958 mm 47 kg n/a 39 000 m 32 500 m ERFB-Smoke-BE 938 mm 45.5 kg n/a 30 000 m 25 900 m ERFB-Smoke-BE/BB 958 mm 47.2 kg n/a 39 000 m 32 500 m		Notes
8.6 kg TNT ERFB-III 938 mm 45.5 kg n/a 30 000 m 29 500 m ERFB-III-BB 958 mm 47 kg n/a 39 000 m 32 500 m ERFB-Smoke-BE 938 mm 45.5 kg n/a 30 000 m 25 900 m ERFB-Smoke-BE/BB 958 mm 47.2 kg n/a 39 000 m 32 500 m	-B-HE	
ERFB-III-BB 958 mm 47 kg n/a 39 000 m 32 500 m ERFB-Smoke-BE 938 mm 45.5 kg n/a 30 000 m 25 900 m ERFB-Smoke-BE/BB 958 mm 47.2 kg n/a 39 000 m 32 500 m	B-HE-BB	
ERFB-Smoke-BE 938 mm 45.5 kg n/a 30 000 m 25 900 m ERFB-Smoke-BE/BB 958 mm 47.2 kg n/a 39 000 m 32 500 m	B-III	90 s burntime
ERFB-Smoke-BE/BB 958 mm 47.2 kg n/a 39 000 m 32 500 m	B-III-BB	90 s burntime
	B-Smoke-BE	60 or 120 s burntime
EBER-Smoke WP 938 mm 47.7 kg p/s 30.000 m 25.000 m	B-Smoke-BE/BB	60 or 120 s burntime
Enrib-online with 300 min 47.7 kg 1/4 50 000 m 25 300 m	B-Smoke WP	7.6 kg WP
ERFB-Smoke WP/BB 958 mm 50 kg n/a 39 000 m 32 500 m	B-Smoke WP/BB	7.6 kg WP

155 mm M483A1 Cargo Round

In October 1980 a Memorandum of Understanding was signed between the USA and the Netherlands under which it was agreed to produce the US M483A1 ICM in Europe. Eurometaal has become the licensee for production of this round for NATO countries. Production of the M483A1 has started at

Eurometaal NR 109 155 mm illuminating projectile

Eurometaal. Early in 1987 Royal Ordnance of the UK was awarded a contract worth £1.4 million to supply composition A5 explosive for bomblets used in the M483A1.

First production deliveries to the Royal Netherlands Army were made in 1989. Eurometaal have released the following specifications on the M483A1

CALIBRE	155 mm
LENGTH FUZED	899 mm
WEIGHT	46.5 kg
NUMBER OF GRENADES	64 M42 and 24 M46
EXPLOSIVE CONTENT, Comp A5	30.5 g (per bomblet)
FUZE	MTSQ M577
MAX RANGE, M109 with charge M4A2	14 320 m
MAX RANGE, M109A1/A2/A3 with	
charge M119	17 740 m
MAX RANGE, M198 with charge M119	17 740 m

The M483A1 has been produced for both the home and export markets and in the future the company may also make the more recent M864 DPICM (qv USA).

NR 109 155 mm Illuminating Projectile

The NR 109 illuminating projectile was developed in 1973, as a replacement for the M118 illuminating projectile to meet a requirement for increased light and shorter burn time. It is based on the American M485E1 projectile. The Eurometaal projectile provides a very high initial light output which decreases with time. This gives nearly constant ground and target illuminating during

The projectile has a standard 2 in fuze-well thread and can be fitted with an MT 565 fuze but the Dutch Army uses a No 150 fuze which is basically the MTSQ 501.

Performance comparison is as follows:

LIGHT OUTPUT (average) **BURN TIME** TIME TO FULL OUTPUT GROUND AREA INTEGRAL 0.5 ft - candle

1 ft - candle 1.5 ft - candle Standard M485E1 780 000 candela 150 s 10-15 s ILLUMINATED AT:

69 s <2 s

Improved NR 109

2 180 000 candela

 $165 \times 10^6 \text{ ft}^2/\text{s}$ $341 \times 10^6 \text{ ft}^2/\text{s}$ $64 \times 10^6 \text{ ft}^2/\text{s}$ $166 \times 10^6 \text{ ft}^2/\text{s}$ $107 \times 10^6 \text{ ft}^2/\text{s}$ 36 106 ft²/s



Complete Eurometaal 105 mm ERM1 HE round (left) with cutaway projectile (right) (Christopher F Foss)

SPECIFICATIONS (NR 109)

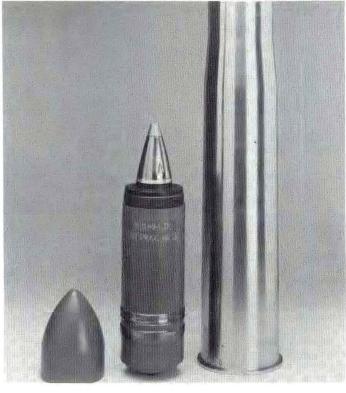
WEIGHT projectile 40.9 kg pyrotechnic charge 2.7 kg LENGTH 700 mm (with fuze) M4 or M119 series PROPELLING CHARGES MAX MUZZLE VELOCITY

charge 7 534 m/s charge 8 685 m/s MAX RANGE

charge 7 18 700 m 19 500 m charge 8 RATE OF DESCENT 4 m/s

Manufacturer: Eurometaal NV, Postbus 419, NL-1500 EK Zaandam, Netherlands

Telephone: (075) 504911 Telex: 19303 Fax: (075) 169396

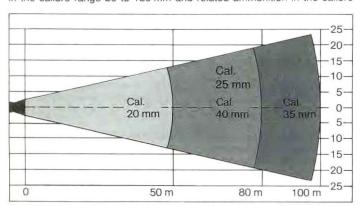


Eurometaal 105 mm Squash Head Practice round (SH/P) NR 110 disassembled to show main components

NWM De Kruithoorn Ammunition

NWM De Kruithoorn is the world's only manufacturer of Break-up Ammunition. The company has developed break-up ammunition in calibres of 20 mm × 139, 20 mm × 137, 25 mm × 173, 35 mm × 228 and 40 mm L/60

Another speciality of NWM is the production of heavy metal penetrators in the calibre range 20 to 120 mm and related ammunition in the calibre



Safety area in front of muzzle for different calibres when firing De Kruithoorn break-up cartridges

range 20 mm up to 30 mm, of which the 30 mm Missile-piercing Discarding Sabot round for CIWS Goalkeeper is unique.

Other NWM products

Ammunition for 20 mm × 139 for automatic cannon Rheinmetall Rh 202, HS 820, Giat F2 and Mauser MK 20.

Ammunition for 25 mm × 137 for automatic cannon Oerlikon KBA, M242. Bushmaster (McDonnell Douglas Helicopter) and Mauser MK 25. Aircraft ammunition for 20 mm × 102 for M61 and M39 cannon. Cartridge cases and synthetic ammunition components.

Break-up Ammunition

NWM Break-up Ammunition can be used in guns with calibres ranging from

The handling, feeding and firing of break-up rounds is identical with target practice or live rounds. Since forces on the gun are the same as in firing of live rounds the break-up ammunition is the solution for testing of guns after repair or overhaul.

Break-up ammunition provides realistic training conditions for gunners because sound, flash and smoke are the same as those in combat. Any aircraft can serve as a simulation target and attack trajectories can be flown just as they would be in combat.

An area in front of the muzzle of only 50 to 100 m long, depending on calibre, and a maximum of 20 m wide is required as a safety area. Such areas can usually be found around gun repair shops and training sites. The

functioning and safety criteria are guaranteed even under extreme temperature conditions.

Available types:

40 mm MN19 for Bofors 40 mm L/70 guns

40 mm MN22 for Bofors 40 mm L/60 guns

35 mm MN16 for Oerlikon cannon

25 mm MN14 for Oerlikon KBA and M242 Bushmaster (McDonnell Douglas Helicopter)

20 mm MN70 for Hispano-Suiza HS 820, Rheinmetall MK 20 Rh 202 and Oerlikon-Contraves KAD cannon

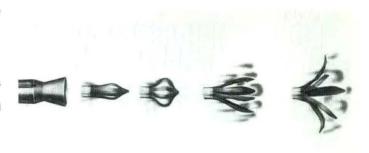
Other break-up types on application.

Status: In current production. In service worldwide.

Manufacturer: NWM De Kruithoorn BV, Poeldonkweg, PO Box 1050,

NL-5200 BCs'-Hertogenbosch, Netherlands.

Telephone: (73) 81 02 22 Telex: 50 229 Fax: (73) 81 03 10



Break-up sequence of De Kruithoorn training ammunition; sequence takes 0.00016 seconds

NORWAY

RAUFOSS Ammunition

The Defence Products Division of RAUFOSS manufactures a wide range of ammunition ranging from 6.5 mm up to 155 mm for land, air and sea applications. This includes the NM102 HEAT 105 mm round for the Leopard 1 tanks of the Norwegian Army, NM140 multipurpose 12.7 mm round for the M2 HB machine gun and the NM75 multipurpose round for the 20 mm FK 20-2 light anti-aircraft gun.

12.7 mm MP NM140 Round

This round has the same ballistic characteristics as the standard United States M8 API round. The NM140 is widely used as combat ammunition for the cannon M2, M3 and M3P mounted on vehicles, helicopters and infantry mountings and can also be used in the GECAL 12.7 mm weapon system.

When impacting a light target such as a helicopter or truck, the round will burst and deliver all of its effect inside the target. The effect is a combination of fragmentation, incendiary and blast. About 15 effective fragments are produced from one projectile.

When impacting armour, the projectile will penetrate 16 mm of armour out to a range of 600 m or 13 mm of armour out to a range of 1000 m.

Single hits will detonate artillery projectiles while ground bursts will produce suppression effect against infantry due to the significant blast, incendiary and fragmentation effect.

The round NM140 is linked together with MP-T NM160 and AP-S. The traced MP round has the same qualities as the untraced round. The tracer has a burning time to more than 1500 m. The AP-S round is optimised to defeat armoured targets and has the same ballistics as the MP rounds. The standard linking ratio is MP:MP-T:AP-S = 1:1:1.

The United States qualification number of the MP NM140 is the Mk 211 Mod 0.

20 mm MPT-SD NM75 Round

This round was developed by the Norwegian Army, Norwegian Defence Research Establishment and RAUFOSS for the 20 mm FK 20-2 LAAG used by the Norwegian and German Armies which use the Rheinmetall Rh 202 cannon. Development was completed in 1972 and volume production began the same year. The basic requirements for the NM75 round were; delayed action after penetrating the aircraft skin and steel/armour protection plates, improved incendiary effect, ability to penetrate armour up to 8 mm thick and steel plates up to 12.7 mm thick at 60° of obliquity, improved penetration and functioning capabilities in shallow angles of impact, fragments large enough to give optimum effect against material targets, improved blast effect, destructive effects of the projectile to be delivered inside the target, tracer fitted, self-destruct after four seconds of flight, safe to store, transport, fire and handle.

20 mm MP M70 Round

This round has the same ballistics as the United States M50 series of ammunition used in the M61 and M39 cannon.

The ballistics of the MP M70 is now redesigned to match the low drag profile of the United States SAPHEI PGU-28 round, which is a projectile based on the multipurpose principles. The advantages of the low drag shape is increased hit probability as well as penetration improvements.

25 mm MP M84 Round

The 25 mm \times 137 MP M84 round is intended for use with the M242 Chain Gun, GAU-12, KBA-BO2B, Giat M811, Mauser MK 25 and 25 mm ADEN gun systems. The MP M84 does not have a tracer element and has been developed for air-to-air and air-to-ground combat use against targets such as aircraft, helicopters, light fortifications and armoured targets with an armour thickness of up to 20 mm.

25 mm MPT-SD M85 Round

This 25 mm \times 137 round is similar ballistically to the M84 but has tracer and self-destruct elements. The tracer is not visible at ranges under 100 m but is visible from 300 m out to 2500 m. The projectile self-destructs after six seconds of flight time.

25 mm ADEN

The RAF uses a 25 mm MP Raufoss round with its ADEN cannon installed in pods on its Harrier GR5 aircraft.

27 mm MP P90 Round

This round is qualified for use in the 27 mm Mauser cannon installed in the Tornado aircraft.

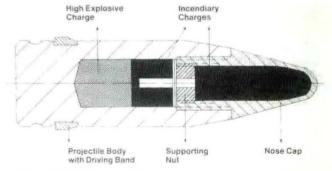
30 mm MP-T ADEN/DEFA ASP

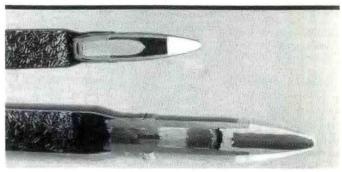
This round has a low drag design with a base bleed charge. At a range of 1000 m, the impact energy of the projectile has been increased by about 50 per cent in relation to older designs. The time of flight has been decreased by approximately 25 per cent.

40 mm Multipurpose Rounds

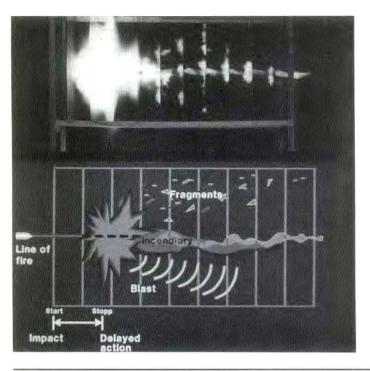
RAUFOSS has developed a multipurpose version of the Bofors 40 mm L/70 round. The round has a tracer and self-destruct elements and the RAUFOSS multipurpose principle based on pyrotechnic ignition is used.

A multipurpose round based on the same principles has been developed for the Bofors 40 mm L/60 gun.





Basic principles of RAUFOSS Multipurpose design used on projectiles from 12.7 mm to 40 mm in calibre



Manufacturer: RAUFOSS A/S, Defence Products Division, N-2831 Raufoss, Norway.

Telephone: (47) 61 52 000 Telex: 71144 RA N Fax: (47) 61 52 001

Photographic and diagramatic indications of RAUFOSS Multipurpose ammunition principle

PAKISTAN

Pakistan Ordnance Factories Ammunition

The main Pakistan Ordnance Factories facility is at Wah Cantt near Islamabad with other facilities at Sanjwal and Havelian. These facilities produce arms and ammunition for the Pakistan armed forces and for export. Included in the Pakistan Ordnance Factories group is a weapons plant, artillery ammunition plant, tank and anti-tank ammunition plant, heavy artillery ammunition plant, a small arms ammunition plant, a bomb and grenade plant, explosives plants, a propellants plant, a filling plant, 12.7 mm Type 54 anti-aircraft gun plant, 12.7 mm ammunition plant, tungsten alloy plant, brass mills and a clothing factory. In addition to a range of small arms ammunition, mortar ammunition, land mines and aircraft bombs, the Pakistan Ordnance Factories produce the following ammunition:

0		
Calibre	Туре	Application
20 mm	API, HEI, TP	US M50 series, for aircraft cannon
23 mm	API, HEI, TP	Chinese design, for aircraft
		cannon
30 mm	API, HEI, TP	Chinese design, for aircraft
		cannon
30 mm	API, HEI, TP	French DEFA design, for aircraft
		cannon
35 mm	HEI, HEI-T, SAPHEI-T,	for Oerlikon-Contraves 2 × 35 mm
	TP and TP-T	towed AAG
37 mm	HEI-T, TPT	for Chinese towed LAAG
60 mm	HE, smoke WP,	for mortar
	Illuminating (red and green)	
87.6 mm	HE, smoke, blank	for 25 Pounder Field Gun
81 mm	HE, smoke WP	for mortar, Thomson Brandt
100 mm	APDS	for Type 59 MBT
100 mm	APFSDS	for Type 59 MBT
105 mm	HESH L35A3	105 mm L7/M68 armed MBT
105 mm	APFSDS L64A4	105 mm L7/M68 armed MBT
105 mm	HE, smoke, blank	for 105 mm howitzers
106 mm	HEAT	for M40/M40A1 recoilless rifle
120 mm	HE	for mortar M44
122 mm	HE	for Chinese Type 54 How
130 mm	HE	for 130 mm M-46 gun or equivalent
155 mm	HE M107	for howitzers M1, M1A2, M45 and

The 105 mm APFSDS round is essentially the British Royal Ordnance L64 round made under licence with a number of improvements including substituting the NQM triple base propellant for the original LM1900 and also removing the support ring to eliminate further gas wash erosion.

M126

In the future, the Pakistan Ordnance Factories intend to undertake local production of 155 mm and 130 mm base bleed projectiles as well as a 155 mm cargo round (Improved Conventional Munition).



Pakistan Ordnance Factories manufactured air defence ammunition, from left to right, 20 mm × 102 API, 30 mm AP (Chinese design), 37 mm HE-T, 37 mm TP-T, 30 mm HE-I and 23 mm API

122 mm Yarmuk Rockets

Pakistan Ordnance Factories now manufacture two types of 122 mm rocket called the Yarmuk. The long-range rocket is called the PIAI while the short-range rocket is called the DFR (Direct Fire Rocket). Both have four wrapround fins that unfold at the rear, a double base solid propellant and a graphite disc end. They have a different venturi to their Chinese and former Soviet equivalents. An HE fragmentation warhead is fitted with a delayed impact fuze. Both are in quantity production and are fired from a 32- or 40-round launcher based on a 6×6 truck chassis.

Also produced is a large variety of military explosives and an affiliate company, Wah Nobel (Pvt) Limited is engaged in the manufacture of commercial explosives.

Manufacturer: Pakistan Ordnance Factories, Wah Cantt, Pakistan. Telephone: (51) 66031-39 Telex: 5840 POFAC PK & 54178 POFAC PK

Fax: (51) 584175



Pakistan Ordnance Factories manufactured anti-tank ammunition, from left to right, 105 mm APFSDS L64A3, 106 mm recoilless rifle, 100 mm, 105 mm HESH L35A3 and 100 mm APFSDS



Pakistan Ordnance Factories manufactured artillery ammunition, from left to right, 105 mm HE, 155 mm HE, 203 mm (8 in), 130 mm HE, 105 mm ICM and

PORTUGAL

Explosivos Da Trafaria SA

In 1970 Explosivos Da Trafaria SA (EXTRA) started to produce defence material and now produces aircraft bombs, mortar bombs, artillery ammunition, demolition charges, flamethrowers, anti-tank and anti-personnel mines as well as a range of civil products. Ammunition production can be summarised as follows:

Calibre	
60 mm	
81 mm	
105 mm	
120 mm	

Type M49A2 HE mortar bomb M43A1 HE mortar bomb

M1 HE projectile, charge and fuze Tampella type mortar bombs

Calibre Type M107 HE projectile, charge, fuze and 155 mm primer 175 mm M437A1 HE projectile, charge, fuze and primer M106 HE projectile, charge, fuze and 203 mm primer

Status: Production as required.

Manufacturer: Explosives Da Trafaria SA, Rua Joaquim Antonio De Aguiar,

66-4°, P-1092 Lisbon Codex, Portugal

Telephone: 69 13 90 Telex: 64053 EXTRAL P Fax: 69 14 61

INDEP Ammunition

INDEP - Indústrias e Participações de Defesa, SA - Portugal, is a joint stock company whose capital is totally owned by the Portuguese Ministry of Defence and is originated from the amalgamation of the military FMBP and FNM factories. It has two main locations: the Braço de Prata facility produces small arms, mortar bombs and artillery ammunition; the Moscavide facility manufactures small arms ammunition.

The ammunition production comprises a range of 5.56 mm, 7.62 mm and 9 mm ammunition, 60 mm and 81 mm mortar bombs, as well as 105 mm (HE and Smoke) and 155 mm M107, HE projectiles.

PROPELLANT WEIGHT charge M3	SPECIFICATIONS (155 mr	n M107 HE projectile)
PROPELLANT WEIGHT charge M3	CALIBRE	155 mm
charge M3A1 2.54 kg charge M4A1 6.08 kg charge M4A2 6.08 kg FILLER WEIGHT 6.62 kg FILLER TYPE TNT MAX MUZZLE VELOCITY cannon M1, M1A1, M45 charge M3 371.9 m/s charge M4A1 563.9 m/s		42 kg (approx
charge M4A1 6.08 kg charge M4A2 6.08 kg FILLER WEIGHT 6.62 kg FILLER TYPE TNT MAX MUZZLE VELOCITY cannon M1, M1A1, M45 charge M3 371.9 m/s charge M4A1 563.9 m/s	charge M3	2.54 kg
charge M4A2 6.08 kg FILLER WEIGHT 6.62 kg FILLER TYPE TNT MAX MUZZLE VELOCITY cannon M1, M1A1, M45 charge M3 371.9 m/s charge M4A1 563.9 m/s	charge M3A1	2.54 kg
FILLER WEIGHT 6.62 kg FILLER TYPE TNT MAX MUZZLE VELOCITY cannon M1, M1A1, M45 charge M3 371.9 m/s charge M4A1 563.9 m/s	charge M4A1	6.08 kg
FILLER TYPE TNT MAX MUZZLE VELOCITY cannon M1, M1A1, M45 charge M3 371.9 m/s charge M4A1 563.9 m/s	charge M4A2	6.08 kg
MAX MUZZLE VELOCITY cannon M1, M1A1, M45 charge M3 371.9 m/s charge M4A1 563.9 m/s	FILLER WEIGHT	6.62 kg
cannon M1, M1A1, M45 charge M3 371.9 m/s charge M4A1 563.9 m/s	FILLER TYPE	TNT
charge M3 371.9 m/s charge M4A1 563.9 m/s	MAX MUZZLE VELOCITY	
charge M4A1 563.9 m/s	cannon M1, M1A1, M45	
9	charge M3	371.9 m/s
cannon M126, M126A1	charge M4A1	563.9 m/s
	cannon M126, M126A1	
charge M3A1 374.9 m/s	charge M3A1	374.9 m/s
charge M4A2 562.4 m/s	charge M4A2	562.4 m/s

9700 m

14 600 m

MAX RANGE

cannon M1, M1A1, M45

charge M3 charge M4A1

cannon M126, M126A1

charge M3A1 9800 m charge M4A2 14 600 m

SPECIFICATIONS (105 mm Ammunition)

Projectile type Smoke DESIGNATION M1 M60

WEIGHT

complete round 19.02 kg 19.85 kg

1.3 kg propellant 1.3 kg 1.85 kg filler 2.2 kg TYPE OF FILLER TNT WP MUZZLE VELOCITY (M102 howitzer) 494 m/s 494 m/s MAX RANGE (M102 howitzer) 11 500 m 11 500 m

Manufacturer: INDEP - Industrias e Participações de Defesa, SA, Rua Fernando Palha, P-1802 Lisbon Codex, Portugal.

Telephone: (1) 351 8584371 Telex: 12 514 INDFBPP P Fax: (1) 351

8582330

Sociedade Portuguesa de Explosivos Ammunition

The Sociedade Portuguesa de Explosivos (SPEL) company was established in 1928 and is currently producing land mines, hand grenades, ignition cartridges, propellant increments, demolition devices, mortar bombs and ammunition. The latter includes the US designed 105 mm HE M643 and the 105 mm smoke M652 rounds.

Status: Production as required.

Manufacturer: Sociedade Portuguesa de Explosivos (SPEL), Avenida Infante Santo, 76 5° - P-1300 Lisbon, Portugal Telephone: 60 30 80 Telex: 12398 SPELEX P

ROMANIA

Romanian Ammunition

The state controlled Romanian defence industry manufactures a wide range of ammunition for artillery, anti-aircraft guns and armoured vehicles, brief details of these are given below.

30 mm HEI-T Ammunition

MUZZLE VELOCITY 1050 m/s MIN TRACE TIME 9 s WEIGHT (complete round) 1076 g WEIGHT (projectile) 360 g 48 g 17.2 g WEIGHT (fuze) WEIGHT (explosive charge) WEIGHT (propelling charge) 189 g WEIGHT (tracer) 12.8 g WEIGHT (cartridge case) APPLICATION 520 g anti-aircraft gun

76 mm Ammunition

Type	Smoke	HE
MUZZLE VELOCITY	222-398 m/s	222-398 m/s
MAX RANGE	8600 m	8860 m
WEIGHT (complete round)	8.30 kg	8.564 kg
WEIGHT (projectile)	6.2 kg	6.27 kg
WEIGHT (cartridge and		
full charge)	2.3 kg	2.3 kg
WEIGHT (bursting charge)	0.04 kg	0.621 kg
WEIGHT		
(smoke composition)	0.60 kg	n/a
WEIGHT (fuze)	0.438 kg	0.438 kg
WEIGHT (full		-
propelling charge)	0.397 kg	0.491 kg
WEIGHT (cartridge case)	1.55 kg	1.55 kg
LENGTH (projectile)	353 mm	n/avail
LENGTH (cartridge case)	386 mm	385 mm
APPLICATION	Mountain Gun Model 82	

76 mm Ammunition

Type	AP	HEAT
MUZZLE VELOCITY	655 m/s	715 m/s
WEIGHT (complete round)	9.33 kg	7.2 kg
WEIGHT (projectile)	6.505 kg	4.65 kg
WEIGHT (bursting charge)	0.065 kg	0.30 kg
WEIGHT (fuze)	0.124 kg	0.052 kg
WEIGHT (cartridge case)	1.55 kg	1.55 kg
WEIGHT (propelling charge)	1.08 kg	0.865 kg
LENGTH (projectile)	274 mm	410 mm
LENGTH (complete round)	620 mm	760 mm
APPLICATION	76 mm guns (inc tank)	

Note: AP round will penetrate 61 mm of vertical armour at a range of 1000 m HEAT will penetrate 194 mm of armour

85 mm Ammunition

MAX RANGE 15 650 m MUZZLE VELOCITY 793 m/s

HE WEIGHT (complete round) 16.15 kg WEIGHT (projectile) 3.54 kg WEIGHT (bursting charge) 0.725 kg WEIGHT (fuze) 0.44 kg WEIGHT (cartridge case) 3.75 kg WEIGHT (propelling charge) 2.60 kg LENGTH (projectile) 402 mm LENGTH (complete round) 960 mm **APPLICATION** M1939 and M1944 AAG, D-44 towed gun,

100 mm Ammunition

100 mm / mmmammon		
Type	APT	APDS
MUZZLE VELOCITY	900 m/s	1400 m/s
WEIGHT (complete round		
with brass case)	30.40 kg	21.2 kg
WEIGHT (complete round		
with steel case)	27.74 kg	n/a
WEIGHT (projectile)	15.88 kg	5.9 kg
WEIGHT (fuze)	0.111 kg	n/a
WEIGHT (propelling charge)	5.50 kg	6.66 kg
WEIGHT (explosive charge)	0.061 kg	n/a
WEIGHT (priming charge)	0.075 kg	n/a
WEIGHT (tracer)	0.039 kg	n/a
WEIGHT (cartridge case brass)		n/a
LENGTH (projectile)	387 mm	212 mm
LENGTH (penetrator)	n/a	120 mm
DIAMETER (penetrator)	n/a	49.5 mm
APPLICATION	100 mm KS-19 AAG, tanks	anti-tank guns

Note: APT - is an armour-piercing tracer projectile with armour-piercing cap and windshield and will penerate 185 mm of armour. APDS will penerate 300 mm of armour

122 mm Ammunition

Type MUZZLE VELOCITY	HE
(full charge)	690 m/s
(reduced charge)	565 m/s
MAX RANGE	15 200 m
WEIGHT (projectile)	21.76 kg
WEIGHT (cartridge case	
full charge)	7.725 kg
WEIGHT (cartridge	
reduced charge)	6.325 kg
WEIGHT (fuze)	0.455 kg
WEIGHT (explosive charge)	3.528 kg
WEIGHT (cartridge case)	3.66 kg
LENGTH (projectile)	560 mm
LENGTH (cartridge case)	447 mm
APPLICATION	D-30

130 mm Ammunition

Type	HE
MUZZLE VELOCITY	525-930 m/s
MAX RANGE	27 500 m

Type	HE
WEIGHT (projectile)	33.4 kg
WEIGHT (cartridge case	
full charge)	25.73 kg
TYPE OF FUZE	V-429
WEIGHT (fuze)	0.44 kg
WEIGHT (explosive charge)	3.64 kg
WEIGHT (full propelling charge)	12.9 kg
LENGTH (projectile)	668 mm
LENGTH (cartridge case)	846 mm
APPLICATION	towed gun Model 1982 and M-46 field gun

152 1	mm.	Ammun	ition
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Calibre

Type

AT-T
) m/s
) m
kg
5 kg
1

Type	Leaflet	Illuminating	HEAT-T
WEIGHT (cartridge case full charge)	17.00 kg	17.00 kg	16.5 kg
WEIGHT (cartridge case reduced charge)	10.70 kg	10.70 kg	n/a
TYPE OF FUZE WEIGHT (fuze)	T-7 0.544 kg	T-7 0.544 kg	impact 0.165 kg
NUMBER OF SHEETS SIZE OF LEAFLETS	2000/2500 100 × 150 mm	nil nil	nil nil
HEIGHT (burst) LENGTH (projectile)	200-250 m 728.8 mm	400-600m 726.25 mm	nil 770 mm
LENGTH (case) APPLICATION	547.5 mm Model 37 and Model 81	547.5 mm Model 37 and Model 81	547 mm Model 81

Manufacturer Romanian state factories. Marketing is carried out by: Romtehnica, 9-11, Drumul Taberei Street, Bucharest, Romania. Telephone: 46 20 87 Telex: 11608 TXKCO/11640 TXNVS

Fax: 12 22 21/40 03 17

SINGAPORE

Singapore Ammunition Production

Chartered Industries of Singapore Private Limited (CIS) constitutes the ordnance business sector of Singapore Technologies. CIS comprises nine main subsidiaries with complementary capabilities in design, engineering, manufacturing and ordnance related activities.

CIS has capacity for a wide range of ordnance activities including the production of ammunition, explosives and pyrotechnics, military electronics, small arms, mortars, anti-tank weapons, anti-aircraft and naval guns, howitzers and military vehicles.

The range of armoured vehicle and artillery ammunition currently manufactured by CIS includes:

20 mm	Mk 12 TP, TP-T, HEI, API, for aircraft cannon
20 mm	M39/M61, TP, HEI, TPT, HEI-T, API, for aircraft cannon
30 mm	ADEN, EP, HEI, SAPHEI, for aircraft cannon
30 mm	DEFA, EP, HEI, for aircraft cannon
60 mm	HE, smoke, for mortars
75 mm	HE, HE-T, TP-T, canister, for AMX-13 light tank
76 mm	smoke grenade for AFV smoke dischargers
81 mm	HE, smoke WP, Illuminating, HE extended range, smoke
	extended range, for mortars
120 mm	HE, smoke WP, HE extended range, smoke WP extended
	range, for mortars
155 mm	HE M107, smoke WP M110, extended range base bleed unit,
	WP
160 mm	HE mortar bomb

CIS also produces supplementary and propelling charges.

Manufacturer: Chartered Industries of Singapore, 249 Jalan Boon Lay, Singapore 2261. (A member of Singapore Technologies) Telephone: 2651066 Telex: RS 38951 CIS Fax: 2616932

Marketed by: Unicorn International, No 3 Lim Teck Kim Road, 11-01/02, Singapore Technologies Building, Singapore 0208. Telephone: 2254788 Telex: RS 39882 Fax: 2687579



CIS manufacture a full range of conventional, extended range and special purpose ammunition

SOUTH AFRICA

ARMSCOR Ammunition

Under the auspices of ARMSCOR (Krygkor) the South African armaments industry produces well over 140 different types of ammunition, ranging from small arms ammunition to long-range artillery rockets and aircraft bombs. Also included are mines, rifle and rocket grenades and pyrotechnics. The industry is scattered around South Africa but the main artillery ammunition filling plant is at Boskop near Johannesburg with propellants and some warheads being produced by Somchem near Cape Town. The main types

of artillery ammunition produced are outlined. Following a major reorganisation, ARMSCOR is now responsible for procurement of equipment for the South African Defence Force while production of former ARMSCOR products, such as ammunition, is now carried out by Denel with Pretoria Metal Pressings being responsible for all ammunition with a calibre of 35 mm and below.

20 mm \times 139 for cannon HSS 820-A, Mk 20 Rh 202, French 20 mm F-2 and so on.

Type WEIGHT	HEI	HEI-T	APC-T*	TP	TP-T
complete shell shell plus fuze filling	314 g 97 g 120 g 9 g	314 g 98 g 120 g 8 g	311 g 100 g 110 g	314 g 97 g 120 g	314 g 98 g 120 g
cartridge case propellant LENGTH	144 g 50 g	144 g 50 g	144 g 50 g	144 g 50 g	144 g 50 g
complete shell with fuze EXPLOSIVE FILLING FUZE MUZZLE VELOCITY TRACING TIME	212 mm 92 mm Hexal P30 nose** 1050 m/s	212 mm 92 mm Hexal P30 nose** 1050 m/s 4 s	212 mm 83 mm — cap 1100 m/s 2 s	212 mm 90 mm — dummy 1050 m/s	212 mm 90 mm — dummy 1050 m/s 4 s

has aluminium body with tungsten core; at 100 m can penetrate 10 mm armour plate at impact angle of 15°, 20 mm at impact angle of 33°, 40 mm at impact angle of 70°
 impact action with self-destruction and 8 m muzzle safety

20 mm MG 151 for MG 151 and GA1 Cannon

Туре	HEI	HEI-T	SAPHEI	TP	TP-T
WEIGHT					
complete round	205 g	205 g	205 g	205 g	205 g
projectile	110 g	110 g	110 g	110 g	110 g
filling	7 g	5 g	7 g	_	_
propellant	20 g	20 g	20 g	20 g	20 g
LENGTH					
complete	146 mm	146 mm	146 mm	146 mm	146 mm
cartridge case	83 mm	83 mm	83 mm	83 mm	83 mm
FILLING	Hexal P30	Hexal P30	Hexal P30	inert	inert
FUZE	nose	nose	base	dummy	dummy

8 m

25

720 m/s

All fuzes are safe to fire in the rain.

MUZZLE

MUZZLE VELOCITY

TRACING TIME

SAPHEI can penetrate 15 mm of armour plate at 100 m (0° NATO (90°) static).

8 m

720 m/s

720 m/s

720 m/s

25

23 mm × 152 B for ZU-23 LAAG

8 m

720 m/s

This family of ammunition has been developed for the former Soviet 23 mm ZSU-23-4 self-propelled anti-aircraft gun system and the towed ZU-23 twin 23 mm light anti-aircraft gun which is currently in service with the South African Army.

Type	APCI-T	HEI
WEIGHT (complete round)	455 g	455 g
WEIGHT (projectile)	187 g	187 g
FILLING	1	Hexal P30
LENGTH (complete)	236 mm	236 mm
LENGTH (cartridge case)	152 mm	152 mm
FUZE	_	nose
MUZZLE SAFETY	8 m	8 m
MUZZLE VELOCITY	975 m/s	975 m/s
TRACING TIME	5 s	_

APCI-T will penetrate 50 mm of armour at a range of 200 m with strong blast and incendiary effects



ARMSCOR 20 mm HSS 820-A ammunition (20 mm × 139)

30 mm DEFA for cannons 550, 552A, 552B, 553

С
g
g
mm
mm
my
m/s
mr

¹IA/SD – impact action/self-destruction ²armour plate at 100 m (0° NATO (90°) static) All fuzes are safe to fire in the rain.

35 mm × 228 for Oerlikon Cannon

This is fired by the twin 35 mm Oerlikon-Contraves GDF series towed anti-aircraft guns used by the SADF and in the new ZA-35 twin 35 mm self-propelled anti-aircraft gun still at the prototype stage and shown for the first time in 1991.

Туре	HEI	PRAC-T
WEIGHT		
complete	1.57 kg	1.57 kg
shell	383 g	457 g
shell plus fuze	550 g	550 g
filling	120 g	
cartridge case	630 g	630 g -
propellant	340 g	340 g



ARMSCOR 35 mm Oerlikon-Contraves ammunition



ARMSCOR 30 mm DEFA ammunition

self-destruct time of 4 to 12 seconds and all fuzes are safe to fire in rain

Туре	HEI	PRAC-T
LENGTH		
complete	387 mm	387 mm
shell with fuze	188 mm	180 mm
EXPLOSIVE FILLING	Hexal P30	
FUZE	nose*	dummy
MUZZLE VELOCITY	1175 m/s	1175 m/s

*direct action with self-destruction and 40 m muzzle safety

35 mm × 228 New Generation

This new generation of 35 mm ammunition has been developed to be fired from the existing Oerlikon Contraves twin 35 mm anti-aircraft gun systems as well as the ZA-35 twin 35 mm self-propelled anti-aircraft gun system and the new single towed eGLaS 35 anti-aircraft gun system. All rounds, including training, are ballistically matched and are identical to the exterior ballistics of the older generation. This family of ammunition has been specifically designed to counter modern anti-aircraft targets and to ensure maximum target penetration with high explosive overpressures to create maximum damage and kill probability.

Type WEIGHT	APCI-T	HEI	HEI-T	SAPHEI	TP-T	TP
(complete round) projectile LENGTH	1.57 kg 550 g					
(complete) LENGTH	387 mm					
(cartridge case) FUZE MUZZLE	228 mm —	228 mm nose	228 mm nose	228 mm base	228 mm —	228 mm —
SAFETY MUZZLE	40 m					
VELOCITY TRACING TIME	1175 m/s 6 s					

APCI-T will penetrate 100 mm of armour at 1000 m SAPHEI will penetrate 12 mm of armour at 1000 m

60 mm Mortar Bombs

ARMSCOR produces high explosive, practice, smoke and illuminating mortar bombs which are fired from the 60 mm mortar installed in the Ratel 60 Infantry Fighting Vehicle and Eland light armoured car used by the South African Army.

SPECIFICATIONS

SPECIFICATIONS		
Type	HE	Smoke
WEIGHT	1.79 kg	1.79 kg
FILLING	RDX/TNT 40:60	smoke
PROJECTILE BODY	forged steel	forged steel
FUZES	V9 direct-acting	V9 direct-acting
	SC12B, short and	
	long time settings	
VELOCITY	3	
charge 0	62 m/s	62 m/s
charge 1	88 m/s	89 m/s
charge 2	111 m/s	111 m/s
charge 3	132 m/s	132 m/s
charge 4	149 m/s	149 m/s
charge 4 plus S	171 m/s	173 m/s
RANGE		
charge 4 plus S	2108 m (max)	2108 m (max)
charge 0	0 to 100 m (min)	0 to 100 m (min)

76 mm Rooikat ammunition

ARMSCOR has developed two types of 76 mm fixed ammunition for use in the 76 mm gun installed in the Rooikat armoured car, APFSDS-T and HE-T.

The APFSDS-T round has a tungsten alloy penetrator with the sabot, fins

and nose shield being of aluminium with the rotating obturator of nylon 66. The HE-T round contains 0.6 kg of RDX/TNT on a 60/40 basis with the tracer being visible for eight seconds. The projectile is fitted with a Point Detonating (PD) and selectable delay fuze which provides a super-quick characteristic of 170 µs or a delay action of between 30 and 70 ms, depending on the tactical situation. Other rounds under development include

SPECIFICATIONS

canister and practice.

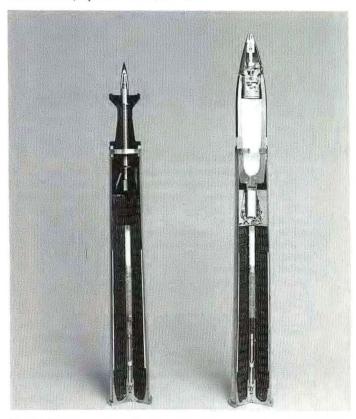
Type	APFSDS-T	HE-T
WEIGHT (complete round)	9.1 kg	12.5 kg
LENGTH	873 mm	908.5 mm
MUZZLE VELOCITY	1600 m/s	915 m/s

90 mm F1 Gun

This 90 mm ammunition is fired from the 90 mm gun installed in the Ratel 90 (6 \times 6) and Eland 90 (4 \times 4) armoured vehicles and can also be fired by the French 90 mm DEFA gun installed in the Panhard AML 90 (4 \times 4) armoured car.

Туре	HEAT	HE	PRAC
WEIGHT (complete)	7.1 kg	8.8 kg	7.1 kg
MUZZLE VELOCITY	750 m/s	640 m/s	750 m/s
FUZE	G4C	FUI F2	dummy

The HEAT projectile can penetrate more than 120 mm armour plate with a 60° angle of incidence or 300 mm at 0° angle of incidence. The filling of the HEAT and HE projectiles is RDX/TNT 60:40.



ARMSCOR 76 mm ammunition for the Rooikat armoured car, APFSDS-T on left and HE-T on right



HE BB for 140 mm (5.5 in) guns



Close-up of HE BB component for 155 mm HE BB projectile

130 mm HE Base Bleed ammunition

As a private venture, ARMSCOR have developed a 130 mm HE base bleed projectile which can be fired from the former Soviet 130 mm M-46 field gun or its Chinese equivalent the 130 mm Field Gun Type 59-1. Firing a standard OF-482M FRAG-HE round, the 130 mm M-46 has a maximum range of 27 150 m.

Firing the new ARMSCOR 130 mm HE BB a maximum range of 39 000 m can be achieved with the base bleed unit attached or 28 000 m with the boat tail attached.

Development of this round has been completed and production can commence when firm orders are placed.

SPECIFICATIONS

CALIBRE MUZZLE VELOCITY WEIGHT

LENGTH FUZE 130 mm 950 m/s

31 kg (depending on fitment of base

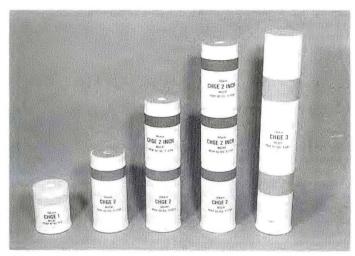
bleed or boat tail unit)

728 mm

can be fitted with M8611 electronic time



ARMSCOR 155 mm ERFB Cargo projectile



ARMSCOR 155 mm propelling charges for G5 and G6 howitzers

140 mm (5.5 in Gun)

ARMSCOR is still producing ammunition for the British 5.5 in Medium Gun which it refers to as the 140 mm G2. Two types of projectile are in production, an HE weighing 36.3 kg and filled with RDX/TNT 50:50, and a Smoke shell weighing 45.9 kg containing four smoke canisters for use up to Charge 4. The HE shell uses a nose DA 117 fuze while the Smoke shell has a 213 time fuze.

The propellant charge system for the G2 consists of charges with the following corresponding muzzle velocities:

Charge 2	389 m/s
Charge 4	570 m/s
Super Charge	633 m/s

The range table is now as follows:

Charge 1	7000 m
Charge 2	10 100 m
Charge 3	12 600 m
Charge 4	15 400 m
Super Charge	16 500 m

ARMSCOR has also developed a Base Bleed (BB) projectile for the 140 mm G2 gun. The BB projectile has a maximum range of 21 000 m and has been qualified with PD M572, and PD M841 contact fuzes, as well as the M8513 proximity fuze. ARMSCOR has quoted that the BB projectile has an even better accuracy performance than its specified Probable Error in Range of 0.6 per cent. The fragmentation effectiveness of the projectile has also been increased by using a high strength steel and an RDX/TNT filling.

155 mm G5 and G6 Howitzers

The 155 mm ammunition developed in South Africa for the G5 towed gunhowitzer and the G6 self-propelled gun-howitzer is optimised for a 45 calibre ballistic system and the projectiles are of the extended range full bore type.

There are two basic types of projectile, that is, bursting projectiles and cargo projectiles. Bursting projectiles include the high explosive projectile manufactured from high grade steel to increase fragmentation and the



ARMSCOR 155 mm ERFB projectiles for G5 and G6 howitzers. Left to right: Smoke WP, HE BB, Illuminating, HE and SCR smoke

white phosphorous projectile with a central bursting charge. For the cargo projectiles, six payloads have been developed:

- (1) screening smoke with a choice of colours; white, red, yellow and blue, for screening/signalling purposes
- (2) illuminating, with a light intensity of 1.5 million candela for battlefield illumination
- (3) leaflet, with approximately 3000 leaflets for information and/or propaganda purposes
- (4) red phosphorous for incendiary and screening purposes
- (5) submunition, with 56 dual purpose (fragmentation and hollow charge) bomblets. The bomblets are activated on impact.
- (6) radar echo or chaff shell. This is designed to produce a scattering effect on enemy radar to deny or confuse target acquisition. Each projectile contains a payload of 13 chaff modules containing different wavelengths of chaff. On ejection from the projectile the chaff is dispersed in cloud formation over the target area.

In addition, a 155 mm practice projectile has been developed which contains a high explosive substitute filling and a small explosive charge to aid observation. It is ballistically compatible with HE and cargo projectiles.

All projectiles are ballistically interchangeable and can be of standard or Base Bleed (BB) type. The base bleed unit can be fitted in the field.

The G5 and G6 charge system comprises three charges whilst allowing sufficient charge overlap. All charges are of the combustible cartridge type which reduces barrel wear when compared to the older generation M11 bagged charge originally used.

Details of the charge system are as follows:

Charge	Muzzle Velocity	Max Range (sea level)
1	350 m/s	9200 m
2	483 m/s	13 400 m
2 + 1 incr	642 m/s	19 000 m
2 + 2 incr	795 m/s	25 400 m
2 + 2 incr*	789 m/s	30 500 m
3	897 m/s	30 200 m
3*	895 m/s	39 000 m

^{*} with base bleed

Three types of fuzes are available: PD M841 point detonating and delay: M8513 radio proximity; M8611 electronic time (3 to 200 seconds). All fuzes are compatible with base bleed applications under extreme conditions.

Туре	HE1	SCR SMK ²	Illum ³	WP	HE BB
WEIGHT (nominal)	44.5 kg	43.9 kg	43.9 kg	47.7 kg	46 kg
PAYLOAD	8.8 kg	13.2 kg	12.0 kg	7.6 kg	8.8 kg
LENGTH (fuzed)	938 mm	938 mm	938 mm	938 mm	958 mm

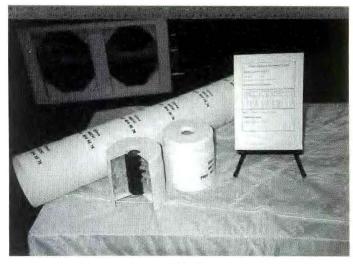
has high fragmentation steel walls and contains 23 per cent more volume for HE (RDX/TNT) than M107

155 mm ammunition developments

Late in 1992 it was announced that a number of developments on 155 mm ammunition were underway in South Africa to give the user greater operational flexibility.

Under development as a private venture is a new Modular Charge System (MCS) comprising identical modules of armoured 2.2 kg which can be used in 39, 45 and 52 calibre 155 mm systems.

For 39 calibre systems a maximum of five modules would be used while for the 45 and 52 calibre systems a maximum of six would be used. The



The new Modular Charge System (MCS) consists of six identical elements (Christopher F Foss)

main advantage of the MCS is ease of handling and logistics as there is no breaking down of charges, in addition, there is no wasting of charges which have to be destroyed. By late 1992, prototypes of the MCS had already been test fired but qualification would take at least another 18 months.

A new 155 mm HE ERFB - BB projectile is under development containing 8.4 kg which, using the existing M53 charge, gives a range of 40.2 km. When fired from a 155 mm/52 calibre ordnance, a range of 42.2 km is achieved

The BB unit is of the screw on type so can be removed under field conditions if not required. Development of this is almost complete and it could be qualified for production in about 12 months.

The current M841 detonating fuze has been upgraded to the M9119. This has been designed to withstand a muzzle velocity of 1200 m/s. rotation speed of 30 000 rpm and set back forces of up to 20 000 g.

In addition, this fuze has a delay unit with a delay time of 10 ms rather than the 50 ms of the existing M841 fuze. The main drawback of the M841 is that it penetrated the ground too deeply before detonating, especially in marginal terrain. The M9119 has been qualified for production which will start on receipt of firm orders. Under early development is a similar upgrade for the M8513, also for use in marginal terrain.

Combustible Charge Cases

In addition to developing Combustible Charge Cases (CCCs) for the 155 mm G6 and G6 artillery systems, CCCs have been developed for a number of other ammunition types manufactured in South Africa including 76 mm (Rooikat), 105 mm (Olifant MBT) and 130 mm (for former Soviet M-46 field

In addition to the above ammunition ARMSCOR also produces naval gun ammunition for 40 mm Bofors L/60 and L/70 guns, 76 mm guns, 4 in Mk 16 and 21 naval guns and 4.5 in naval guns Mks 3 to 5.

Manufacturer: Enquiries to ARMSCOR, Private Bag, X337, Pretoria 001, South Africa

Telephone: (012) 292 9111 Telex: 320217

SPAIN

Barreiros Ammunition

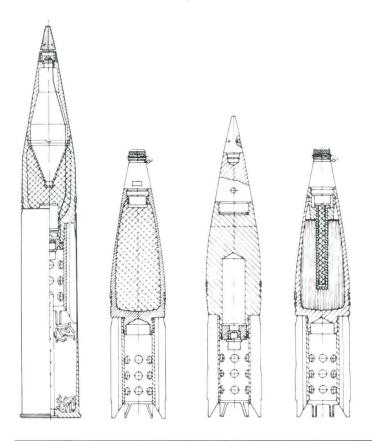
Barreiros Hermanos manufactures a wide range of ammunition for both army and navy use. Listed below is a résumé of army ammunition manufactured by the company.

Calibre	Type	Name	Application
90 mm	HE	M71	filling of TNT or Comp B for M47 and
			M48 tanks, M117 and M118 anti-aircraft
			guns
90 mm	HEAT	M431	available with or without tracer, for M47
			and M48 tanks
90 mm	Smoke WP	M313	filling of WP, for M47 and M48 tanks,
			M117 and M118 anti-aircraft guns
90 mm	HE	n/a	fin-stabilised, for vehicles armed with
			90 mm French F-1 gun such as Panhard
			AML 90

Calibre 90 mm	Type HEAT	Name n/a	Application fin-stabilised, for vehicles armed with 90 mm French F-1 gun, also training version
90 mm	Smoke WP	n/a	fin-stabilised, for vehicles armed with 90 mm French F-1 gun
105 mm	HEAT	M456	available with or without tracer, for tanks armed with 105 mm L7/M68 series rifled tank gun such as Leopard 1, M48A5, M60, and Centurion
105 mm	Blank	M395	for 105 mm M101 and M102 howitzers, 105 mm M52 and M108 self-propelled howitzers and OTO Melara 105 mm Pack Howitzer
105 mm	HE	M1	available with TNT or Comp B filling, for M101, M102, M52, M108 and Model 56 howitzers

contains four smoke canisters

³has light intensity of 1.5 million candela for burning time of 90 seconds



Calibre 105 mm	Type Smoke WP	Name M60	Application filling WP, for M101, M102, M52, M108 and Model 56 howitzers
155 mm	HE	M107	filling TNT, for 155 mm M114 towed howitzer and M44 and M109 series of self-propelled howitzers
155 mm	Illuminating	M118A2	filling illuminous for 155 mm M114 towed howitzer and M44 and M109 series of self-propelled howitzers
155 mm	Smoke WP	M110	filling WP, for 155 mm M114 towed howitzer and M44 and M109 series of self-propelled howitzers

Manufacturer: Barreiros Hermanos Internacional SA, C/Velazquez 10, Madrid-6, Spain.

90 mm fin-stabilised ammunition for French F-1 gun manufactured by Barreiros includes (from left to right) HE, HEAT, practice AT and Smoke WP

EXPAL Ammunition

In addition to manufacturing aircraft bombs, demolition charges and land mines EXPAL manufactures the following types of ammunition:

Calibre Type

20 mm 20 mm × 102 Vulcan

20 mm 20 mm \times 70 HE-T, HEI, HEI-T, AP-T, TP, and TP-T for Oerlikon

Mk 2 and Mk 4

40 mm L/70 Bofors, HE-I, HEI-T, PFHE and ET

105 mm HE M1, WP M60, Illuminating M314A3 for howitzers

105 mm HC M84A1

155 mm HE M107, Illuminating M485A2 for howitzers

155 mm Smoke WP, M110

155 mm HE ERFB and HE ERFB/BB

155 mm HC M116A1

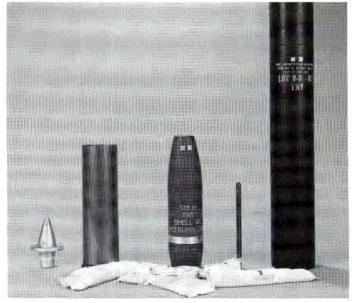


EXPAL M314A3 105 mm illuminating howitzer ammunition

EXPAL also manufactures 76 mm TP-T, HE and PF VT, propellant charges, artillery and bomb fuzes, special forces weapons, pyrotechnic devices and associated components.

Manufacturer: EXPAL - International Division, Orense, 68 10th Floor, E-28020 Madron, Spain.

Telephone: (34) 1 571 52 71 Telex: 43484 XPALE Fax: (34) 1 571 26 61



EXPAL M1 105 mm howitzer ammunition

SANTA BARBARA Ammunition

The SANTA BARBARA concern manufactures a wide range of ammunition for the Spanish armed forces and for export, details of which are as follows:

20 mm Oerlikon

Type OERLIKON DESIGNATION	HEI MSA	SAPHEI PSA	TP-T ULA
WEIGHT complete	324 g	344 g	340 g
filling	18 g	5.4 g	_
propellant	56 a	56 a	53 a

25 mm Oerlikon

HEI-T	SAPHEI-T	APDS-T	TP-T
SLB	PLB	TLB	ULB
500 g	500 g	480 g	500 g
27 g	11 g		
91 g	91 g	105 g	91 g
	SLB 500 g 27 g	SLB PLB 500 g 500 g 27 g 11 g	SLB PLB TLB 500 g 500 g 480 g 27 g 11 g —

35 mm Oerlikon

Type	HEI	SAPHEI-T	TP-T
OERLIKON DESIGNATION	MDS	PLD	ULD
WEIGHT			
complete	1.58 kg	1.552 kg	1.567 kg
filling	112 g	22 g	_
propellant	330 g	330 g	333 g

105 mm Howitzer

This is the HE M1 round suitable for M103, M137, OTO Melara Model 56, Spanish R50 and R58 howitzers. Weight of the projectile is given as 14.97 kg and SANTA BARBARA also produces a seven-charge propellant system for this round.

Also produced is the 105 mm Illuminating M314A3 (local designation ME-314) and a Smoke projectile known as the M84C. The latter weighs 15 kg, is 460 mm long and emits smoke for 40 seconds. Maximum range is

105 mm APFSDS-T C-437

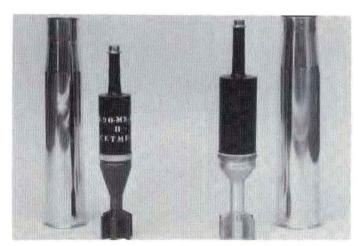
In 1984 SANTA BARBARA announced that it had developed an APFSDS-T round which can be fired from the AMX-30, M60 series, Leopard 1 and all other tanks fitted with the 105 mm gun.

SPECIFICATIONS

CALIBRE	105 mm
WEIGHT	
complete round	18 kg
penetrator	5.65 kg
propelling charge	5.85 kg
LENGTH	
complete round	996 mm
penetrator	435 mm
MUZZLE VELOCITY	1480 m/s
TRACER DURATION	3.5 s
CASE	brass
PRIMER	electric
PROPELLING CHARGE	single base, multi-perforated
PENETRATION	
CHARACTERISTICS	
single NATO target	
at 60°	5000 m
triple NATO target	
at 65°	5000 m
MAX PRESSURE AT	
+21°C	3400 kg/cm ²

The C-437 penetrator uses a three-segment sabot and the nose is protected during flight by an aluminium windshield. On impact with the target a series of three wads or cylinders under the windshield and around the penetrator core is compressed and not only prepares the penetration zone but also serves to prevent rebound from armour set at high angles of incidence. Part of the kinetic energy in the core is used to raise the temperature of the impact zone to soften the material, producing a number of particles behind the armour. The penetration hole is between 60 and 70 mm in diameter.

A 90 mm APFSDS-T round has also been developed.



Left, 90 mm ME-431 round; right, 105 mm HEAT-FS round



Left, SANTA BARBARA 90 mm APFSDS-T round; right, SANTA BARBARA 105 mm C-437 APFSDS-T round

90 mm ME-431 (US M431)

This 90 mm hollow charge ammunition is designed to be fired by M47 and M48 tanks fitted with the 90 mm gun. The projectile consists of a steel body which holds the explosive charge and the cone, an electric primer (piezoelectric) that initiates the fuze when hitting the target, and aluminium fins. The obturator is floating and made of plastic. A tracer element is fitted.

105 mm Tank Gun

Intended for use on the gun fitted to Spanish-produced AMX-30 tanks, the following types of ammunition are produced in addition to the 105 mm APFSDS-T C-437 already covered in some detail:



155 mm Illuminating projectile ME-485 Para Obuses 155 mm cutaway to show main components

Type DESIGNATION WEIGHT	HEAT OCC-105-F2	TP-T SCC-105-F2	HE OE-105-60	Smoke OFPH-105-F1
complete	22.2 kg	22.2 kg	21 kg	21.7 kg
projectile	10.95 kg	10.85 kg	12.1 kg	12.7 kg
propellant	4.7 kg	4.7 kg	2.4 kg	2.4 kg

122 mm Gun

This is a 122 mm HE shell weighing approximately 22.7 kg with a three-charge propellant system contained in a 3 kg brass cartridge case. Charge 1 weighs 3.9 kg, Charge 2 and Charge 3 both weigh 1.1 kg. It is fired from the Spanish 122 mm L46 Trubia 390/2 gun.

Also in production for the 122 mm L/46 Trubia 390/2 gun is a 122 mm HE BB. The projectile weighs 23.5 kg and is 660 mm long. Maximum range when fired using Charge 7 from the Trubia gun is 25 000 m. The projectile may be fitted with either the PD M557 or MTSQ M564 fuzes. It is claimed

that this projectile can be fired from other 122 mm guns providing the muzzle velocity is of the order of 800 m/s.

155 mm Howitzer

This is the universal HE M107 produced for the usual range of American 155 mm howitzers. Weight of the projectile is given as 43.6 kg.

Also in production is the Illuminating M485A2 projectile and a Smoke projectile known as the M116C. The illuminating projectile has the local designation of the ME-485 Para Obuses 155 mm, it weighs 41.5 kg, is 720 mm long and has a maximum range of 15 000 m. This contains five smoke-producing canisters that continue to produce smoke for 60 seconds after base ejection. Weight is 43 kg, length 700 mm and maximum range (Charge 7) is 13 500 m.

Manufacturer: SANTA BARBARA SA, Julian Camarillo 32, E-28037 Madrid, Spain.

Telephone: 585 01 00 Telex: 23228 ENSAB-E Fax: 585 02 68

Placencia Ammunition

For over 40 years the Sociedad Anónima de Placencia de las Armas, Andoain (Guipuzcoa), has been licensed by the Swedish company Bofors to produce the Bofors 40 mm L/70 towed anti-aircraft gun and its associated ammunition. In its Andoain and Placencia facilities weapons have been built for the Spanish Army (400) and for export; many of the 40 mm Bofors anti-aircraft guns used by the Spanish Navy have been built by the company which has also built them for export.

More recently the company has overhauled Bofors 40 mm L/70 anti-aircraft guns of the Spanish armed forces as well as Oerlikon-Contraves twin 35 mm and single towed anti-aircraft gun systems.

It has also manufactured, under subcontract to MOWAG of Switzerland, VCTP infantry combat vehicle turrets complete with their 20 mm cannon.

In addition to producing some two million rounds of 40 mm ammunition in three basic types (L/60 and L/70) it has also been involved in the production of 20 mm and 105 mm ammunition, fuzes as well as parts for the Spanish built AMX-30 MBT.

It has also started manufacturing the United States CD-850-6 transmission for armoured fighting vehicles such as the AMX-30.

Manufacturer: Sociedad Anónima de Placencia de las Armas, Apartado de correos No 8, Andoain (Guipuzcoa), Spain.

Telephone: (43) 592011 Telex: 36176 SAPA-E

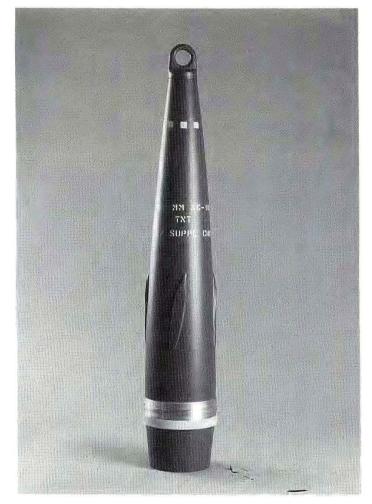
FOREX SA Ammunition

FOREX SA manufactures a wide range of ammunition for land service and naval guns. Using two factories at Burgos and Vitoria, FOREX SA also provides technical know-how and can supply complete package deals to improve outdated processes or provide turnkey plants. They also develop new generation ammunition according to required specifications.

In production are the following ammunition types for artillery:

Calibre	Type
105 mm	HE M1 for howitzers
105 mm	Smoke WP for howitzers
105 mm	Illuminating for howitzers
122 mm	HE
130 mm	HE
155 mm	HE M107 for NATO howitzers
155 mm	Illuminating equivalent to M485A2
155 mm	Smoke WP M110 for NATO howitzers
155 mm	HE ERFB
175 mm	HE M437 for M107
203 mm	HE M106 for NATO howitzers

Manufacturer: FOREX SA, Apartado 1534, E-01080 Vitoria-Gasteiz, Spain. Telephone: (945) 24 13 50



155 mm HE ERFB projectile produced by FOREX SA

DEFTEC 105 mm HEAT-T Round

DEFTEC (Defence Technology) of Spain, a company jointly formed by MBB of Germany and SANTA BARBARA of Spain, announced in 1992 that they had developed a new generation 105 mm HEAT-T round.

This is ballistically identical to the standard US-designed M456 HEAT-T round and can be fired from any 105 mm L7/M68 gun without modification to the weapon or the tank.

Unlike the earlier M456 round, the new Spanish round will penetrate the NATO double heavy target, NATO triple medium target and NATO triple heavy targets, it also has greater fragmentation effect.

Two different types are available, the OWC and the HWC. For increased armour penetration a detonation wave shaper is included in the rear part of the filling.



SPECIFICATIONS

CALIBRE 105 mm WEIGHT (complete round) 22 kg WEIGHT (projectile) 10.7 kg WEIGHT (explosive) 1.4 or 1.5 kg LENGTH 1015 mm **PROPELLANT** triple base MUZZLE VELOCITY 1174 m/s MAX PRESSURE 3800 kg/cm² TRACE TIME 3 s

Status: Development complete. Ready for production.

Manufacturer: DEFTEC SA, PO Box 524, Carretera de Murcia, s/n El

Fargue, E-18182 Grenada, Spain.

Telephone: (34) (58) 20 60 02 Fax: (34) (58) 28 96 35

DEFTEC 105 mm HEAT-T round cutaway to show interior of projectile (Christopher F Foss)

SWEDEN

Bofors Ammunition

Bofors 40 mm L/70 Ammunition

The following types of ammunition are available for the 40 mm L/70 air defence and ground support guns:

Type WEIGHT	PFHE Mk 2	PFPPX (HV)	HE-T	APFSDS-T	TP-T	MP-T
complete round	2.4 kg	2.5 kg	2.5 kg	2.3 kg	2.5 kg	2.5 kg
shell	0.88 kg	0.975 kg	0.960 kg	0.5 kg	0.960 kg	0.940
explosive	0.120 kg	0.120 kg	0.102 kg	_	_	0.105
TYPE OF EXPLOSIVE	octol	octol	hexotonal	_	_	A4 + in
No TUNGSTEN PELLETS	650	1100	_	_	_	_
ROUND LENGTH	534 mm	534 mm	534 mm	520 mm	534 mm	534 mm
MUZZLE VELOCITY	1025 m/s	1012 m/s (1100 m/s)	1005 m/s	1480 m/s	1005 m/s	1025 m/s

The proximity-fuzed prefragmented ammunition (PFHE) is optimised to combat aerial targets of all types. It operates according to the Doppler principle and has an effective triggering distance against aircraft of 6 to 7 m. Against missiles and other small targets the effective triggering distance is 4.5 m. The new Mark 2 version now available has an improved triggering distance against missiles. Against a sea-skimmer at 5 m altitude the effective triggering distance is about 3 m. This increases the probability of an effective burst due to the effective target area being increased 50 to 350 times.

PFPPX/PFPPX-HV (3P/3P/3P-HV)

The Prefragmented Programmable Proximity fuzed round (3P) is individually programmable for six different function modes. The programming is effected in the gun just milliseconds before firing.

The functions are: time gated proximity, time gated proximity with impact priority, time function, impact with post impact delay, armour-piercing and conventional proximity.

The 3P version with a MV of 1012/m is ballistically matched to the external ballistics of the HE-T shell. The 3P-HV is intended for the new 40 mm TRINITY gun system and has a MV of 1100 m/s.

With exception of the MV, both rounds are identical. The fuze proximity function has a triggering distance of about 8 m against aircraft and helicopters and about 5 m against missiles and other small targets. The time gated proximity function ignores all kinds of signals outside the gate making the fuze virtually uneffected by interaction from ECM and other influences.

The 3P shell is equipped with about 1100 tungsten spheres of 3 mm diameter permitting penetration of more than 16 mm duraluminium

The time function is highly accurate (less than 0.5 per cent of predicted time of flight) and can be used for combat of concealed targets and soft ground targets. The armour-piercing function gives behind armour effect against the majority of lightly armoured targets.

When not being programmed the fuze operates as a conventional proximity fuze with impact function.

APFSDS-T

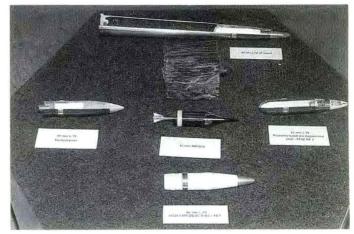
The APFSDS-T round is mainly intended for the 40 mm Combat Vehicle 90 and other vehicles equipped with a Combat 40 mm weapon.

The projectile has tungsten penetrator, four fins, traces and a three parted sabot with a plastic device permitting automatic fire.

The penetration capability exceeds 100 mm of RHA at 1500 m.



Bofors 40 mm PFHE projectile for L/70 gun



A selection of 40 mm ammunition, from top, clockwise, complete 3P round, PFHE Mk 2 projectile, HE-T projectile and MP-T projectile. In the centre is the APFSDS-T projectile

MPT

The Multi Purpose Tracer round is a complement to the PFHE Mk 2 shell for combat of surface, ground targets with and without armour and aerial targets.

The MPT shell is characterised by fragment and incendiary effect after penetration of the target. Penetration capability is typically 20 mm RHA at 1000 m.

The shell is equipped with a pyrotechnical initiation device which on impact ignites the incendiary pyrotechnic and high explosive giving narrow cone of highly effective fragments inside the target as well as incendiary effect at long duration.

Bofors 105/50 TPDS-T Round

During 1982 AB Bofors introduced a new TPDS-T round for use with any 105 mm tank gun of the L7 family. The projectile used with the round provides a flat trajectory out to a range of 2600 m but after that range ballistic performance is degraded by the use of fixed fins on the all-steel projectile body. The fins reduce the projectile maximum range to less than 7000 m. The projectile is held in a driving sabot which starts to disintegrate directly after leaving the gun muzzle. The prefragmented sabot shatters into small splinters within a space cone defined by a 20° included angle and a range of 150 m. The sabot base has a stable trajectory with a maximum flight distance of 1000 m. The barrel weight of the projectile is low, therefore the round requires only a relatively small propellant load resulting in low barrel wear.

SPECIFICATIONS

CALIBRE	105 mm
WEIGHT	
complete round	13.4 kg
projectile/sabot assembly	3.1 kg
cartridge case	5.6 kg
propellant, nominal	4.4 kg
primer	0.1 kg
wear reducing liner	0.2 kg
MUZZLE VELOCITY (+15°C)	1535 m/s
TRACER BURNING TIME	2.5 s



Bofors 105/50 TPDS-T round complete

106 mm Ammunition for 106 mm M40 Recoilless Rifle

Bofors has developed a new 106 mm round for the widely deployed M40 recoilless rifle called the 106 3A-HEAT-T. This round has the capability to penetrate Explosive Reactive Armour (ERA) without the loss in penetration performance, the penetration of the round of more than 700 mm of RHA or behind ERA in RHA. In addition the round is capable of penetrating the NATO heavy triple target with add on ERA. Development of this round is now complete and pre-production is underway.

SPECIFICATIONS (106 3A-HEAT-T)

CALIBRE 106 mm WEIGHT OF ROUND 13 kg ROUND LENGTH 905 mm MUZZLE VELOCITY 570 m/s WEIGHT 5.5 kg projectile explosive 1 kg EXPLOSIVE TYPE octol **FUZE TYPE** base impact TRACER DURATION 5 s

90 mm Ammunition for Bofors KV 90 S 73 Gun

The Bofors range of 90 mm ammunition is intended for use on the Bofors KV 90 S 73 gun fitted in the turret of the lkv 91 tank destroyer. The 90 mm rounds are fixed and use finned projectiles. The 90 mm range has been in production for some years but has recently been updated and considerably

improved. The 90 mm 3A-HEAT-T projectile represents a significant increase in penetration performance together with an efficient capacity against active armour (hence 3A). Significantly more than 500 mm penetration can be achieved at optimum stand-off.

SPECIFICATIONS Type CALIBRE	HEAT-T 90 mm	3A-HEAT-T 90 mm	HE-T 90 mm	HEAT-T 90 mm	3A-HEAT-T 90 mm
ROUND WEIGHT	10.0 kg	10.1 kg	12.3 kg	10.7 kg	10.8 kg
ROUND LENGTH	1038 mm	1038 mm	910 mm	889 mm	889 mm
MUZZLE VELOCITY	660 m/s	653 m/s	600 m/s	840 m/s	833 m/s
PROJECTILE WEIGHT	3.7 kg	3.8 kg	6.7 kg	4.5 kg	4.6 kg
EXPLOSIVE WEIGHT	0.6 kg	0.6 kg	1.45 kg	0.6 kg	0.6 kg
EXPLOSIVE TYPE	octol	octol	hexotol	octol	octol
FUZE TYPE	base impact	base impact	point impact delay	base impact	base impact
TRACER DURATION	2.5 s	2.5 s	5 s	3 s	5 s

BONUS

In March 1990 Bofors announced that the Swedish Defence Materiel Administration had contracted the company to start development of the BONUS 155 mm sensor fuzed anti-tank artillery projectile.

Prior to this, two project definition phases had been successfully completed during which period extensive testing of the descent dynamics, the infrared sensoring and the warhead dynamics had been carried out.

For BONUS, Bofors is prime contractor with Intertechnique being responsible for the submunitions optronic triggering device.

At a gun position, BONUS is handled in exactly the same way as any conventional projectile. Before firing over the target area the electronic time fuze is set to start the first stage of the separation.

It was originally expected that each BONUS projectile would carry three submunitions, but it was subsequently decided to reduce this to two submunitions with increased warhead penetration characteristics.

The 155 mm projectile is spin-stabilised and fitted with a base bleed unit to give a maximum range of 25 000 m. When a predetermined point in the trajectory is reached, and at an altitude of 1000 m, an expelling charge ignites and the two submunitions are ejected rearwards.

The submunitions, which weigh 6.5 kg each, are scattered. The infra-red sensor and two wings then unfold and the submunitions are wing-stabilised during descent. With an inclination of 30° in relation to the line of descent each submunition can search for the target area in a helical pattern.



One of the two submunitions used with the Bofors 155 mm BONUS antiarmour projectile



90 mm ammunition for Bofors KV 90 S 73 aun

Each submunition covers a large search area and at an altitude of approximately 150 m the search mode starts and the warhead initiates immediately after target detection.

The top attack submunition with its SFF (Self-Forging Fragment) has an initial velocity exceeding 2000 m/s.

Although designed for 155 mm artillery weapons, BONUS can also be integrated with other weapon systems such as artillery rockets and aircraft bombs

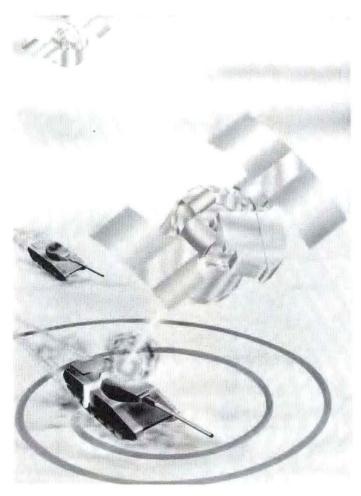
By 1991 the projectile was at full-scale development stage and is expected to be completed late in 1994. Individual components of BONUS, for example the seeker and the warhead, have already been demonstrated.

BONUS weighs 42.5 kg complete with each sublet weighing 4 kg. The sublet warhead is 120 mm in diameter and 82 mm high.

Bofors 155 mm High Explosive Extended Range (HEER) Projectiles

Bofors has developed a new 155 mm High Explosive Extended Range (HEER) projectile which can be fired at ranges up to 30 000 m from all Western-manufactured 155 mm guns. It is compatible with internationally adapted fuzes. The range increase is obtained by optimising the external ballistics and with the addition of a base bleed unit. Large numbers of these projectiles have been delivered to India, for use with the FH-77B, and more recently Sweden.

Two versions of the 155 mm HEER projectile are produced, one with a TNT filling and the other with a Composition B filling



Artist's impression of the Bofors 155 mm BONUS anti-armour projectile over the target area



Bofors 155 mm HEER projectile

SPECIFICATIONS

CALIBRE 155 mm
FILLING TNT 8.5 kg
COMPOSITION B 9 kg
WEIGHT
with ZELAR fuze 42.25 kg
without ZELAR fuze 41.3 kg
LENGTH
with ZELAR fuze 884 mm

Indian 155 mm Ammunition

without ZELAR fuze

The order placed by India in 1986 for over 400 FH-77 field howitzers also provided for the production and supply of ammunition. In addition, Bofors has developed several new types of 155 mm round to meet Indian requirements.

787 mm

The initial Indian contracts called for two types of high explosive projectile, the standard US M107 with a maximum range of 24 000 m when fired from the FH-77 and the Bofors 155 mm HEER previously described.

The 155 mm HEER has a nominal range of at least 30 000 m when fired from the FH-77 under normal conditions but the temperatures and altitudes at which the FH-77 has been fired in India have resulted in ranges of

The success of HEER in Indian service led to requests for new enhanced range projectiles with smoke and illuminating payloads which have also now been supplied. Both the new types are similar to HEER but lack the base bleed unit and both can achieve a maximum range of 24 000 m.

In the case of the extended range projectile, the problems that would normally have resulted from the increased spin utilised to enable the projectile to achieve its range requirements were overcome by the introduction of four small strakes placed close to the projectile nose. These strakes gradually reduce the projectile's inherent spin allowing the illuminating payload and its associated parachute to make a clean exit from the base of the projectile at the desired point in the trajectory.

The new extended range illuminating projectile is used in India alongside the Bofors 155 mm Mira projectile (qv) which has a maximum range of 18 000 to 20 000 m.

Bofors developed another smoke projectile in response to an Indian request. This is an infra-red screening projectile with a range of 18 000 to 20 000 m and a screening smoke production time of three minutes, compared to the more usual six minutes.

The ammunition supplied to India also included a 155 mm cargo round carrying 72 M42/M46 type bomblets.

Status: In production.

BOSS Terminal Guided Munition

BOSS is the designation for a 155 mm terminal guided munition designed to be fired from a 155 mm howitzer as an effective means of combating hard targets.

The BOSS projectile, weighing approximately 40 kg, is handled in the normal way at a gun position. Information on elevation, charges and time in trajectory is programmed into the projectile. As the projectile leaves the muzzle four fins fold out and stabilise the shell. In the downward phase of the trajectory a battery is activated. The projectile's space orientation is determined by a rate gyroscope. The nose cone is ejected and four control surfaces fold out. The projectile is then roll-stabilised and can obey guidance commands.

The target search mode is then initiated. The whole target area is searched and information regarding combat vehicles present in the area is stored in a computer. A preprogrammed selection algorithm enables the most probable target to be designated. The projectile then starts to home in on the designated target. Conical scanning is utilised to track the target during the entire homing phase. BOSS is guided continuously right up to impact, the final guidance phase being by dead reckoning. The concept, which has a range in excess of 20 000 m, can home in and hit a target at a large radial distance from the ballistic point of impact. The powerful angled, shaped charge combined with the angle of attack against the roof of a combat vehicle, will produce an effect that will be more than sufficient to knock out any future combat vehicles.

The BOSS studies have been commissioned by the Swedish Defence Materiel Administration (FMV) as feasibility studies in which the main effort is to be concentrated on the target searching unit. It is in this unit that the processing and evaluation of measurement data about target and background characteristics are performed. The problem of obtaining the necessary contrast in certain snow conditions is apparently not to be underestimated.

155 mm Illuminating Projectile Mira and Mira ER (Extended Range)

This 155 mm illuminating projectile consists of the projectile body, canister containing all components for the flare and parachute system, mechanical time fuze and bottom. The Mira functions as follows; when the time, for which the fuze has been set, has elapsed the fuze initiates the separating charge which in turn initiates the delay charge. The pressure formed by the combustion of the separating charge forces the canister out of the projectile body. The brake parachute opens and reduces the speed of the canister in its trajectory. The brake flaps of the rotation brake are extended so reducing the spin. The delay charge then ignites the second separating charge. The pressure developed in the space behind the separating charge forces the



155 mm illuminating projectile Mira



155 mm illuminating projectile Mira ER (Extended Range)

flare and the main parachute out of the canister. The flare is ignited, the main parachute opens and the ignited flare suspended by the main parachute then slowly descends. At a height of 340 m and after a burning time of 38 seconds, an illumination of five lux is obtained over an area 1140 m in diameter. The Mira projectile has a Swiss Dixi 525 EN 3 fuze which can be set for delays of 1.2 to 80 seconds. The standard 155 mm Mira projectile has a maximum range of 18 km but recently an extended range version has been developed with a maximum range of 27 km.

105 mm Illuminating Projectile Luma Mk 2

The 105 mm illuminating projectile Luma Mk 2 is essentially a scaled down version of the Mira. Its main features are a light with a high uniform intensity and with a colour composition well adapted to the sensitivity of the human eye. It also features balancing of the luminous intensity, rate of descent and burning time so that the efficient illumination of the terrain is obtained during the entire burning time. In addition it has a high degree of functioning reliability and an extensive shelf life.

SPECIFICATIONS

OI LON IOMITORO			
Туре	Mira	Mira ER	Luma Mk 2
CALIBRE	155 mm	155 mm	105 mm
WEIGHT	43 kg	43 kg	14.3 kg
LENGTH	715 mm	902 mm	474 mm
LUMINOUS INTENSITY	2.2 Mcd	2.2 Mcd	0.7 Mcd
BURNING TIME	60 s	60 s	30 s
RATE OF DESCENT	4 m/s	4 m/s	5 m/s
RANGE	18 000 m	27 000 m	14 000 m



105 mm illuminating projectile Luma Mk 2

Bofors 20 mm Ammunition

The Swedish Army still has a number of Bofors 20 mm light anti-aircraft guns in service and ammunition for these is made, as required, by LIAB, a subsidiary of Bofors.

SPECIFICATIONS

HE-T Type CALIBRE 20 mm SHELL BODY steel LENGTH (of shell with fuze) TYPE OF FILLING 92 mm

Hexotol (60% RDX and 40% TNT)

WEIGHT (of filling) projectile 121 g TRACER BURNING TIME 3.5 s

FUZE TYPE impact, super-quick ARMING 2 m from cannon muzzle SELF-DESTRUCT mechanical, 8 s ±2 s

HE-T Type WEIGHT OF FUZE 33 g AP-T Type CALIBRE 20 mm MUZZLE VELOCITY 900 m/s WEIGHT (of AP part) 90 a TYPE OF PENETRATOR heavy metal core

LENGTH (of shell) 82 mm WEIGHT (of projectile) 133 g TRACER BURN TIME 3 s

Note: Although this round is adapted to the 20 mm cannon HS 804 it can easily be adapted to other 20 mm weapon systems. In addition there is a practice tracer projectile available for the AP-T round.

Status: Production as required. In service with the Swedish Army.

155 mm Smoke Ammunition

The 155 mm smoke system is a modern, advanced artillery smoke ammunition with a high functional reliability in all situations. The 155 mm smoke family comprises three different rounds:

- (1) 007 smoke shell, conventional smoke, range 18 000 m
- (2) 007 IR smoke shell, IR screening smoke, range 18 000 m
- (3) 007 ER smoke shell, conventional smoke, range 24 000 m.

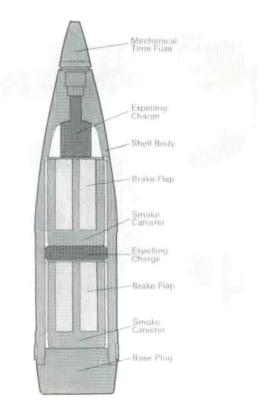
The above range values refer to the Bofors FH-77B system, but the ammunition is also compatible with the FH-70 and M109 and similar systems

The design is based on a payload of two smoke canisters which are separated in the final part of the trajectory. A time fuze should therefore be used and Bofors recommend the Junghans DM 153.

SPECIFICATIONS

Type	007	007 IR	007 ER
WEIGHT	43.3 kg	43.3 kg	43.3 kg
LENGTH	0.717 m	0.717 m	0.880 m
SMOKE DURATION	6 min	3 min	6 min
RANGE	18 000 m	18 000 m	24 000 m

Manufacturer: Bofors AB, S-691 80 Karlskoga, Sweden. Telephone: (0586) 810 00 Telex: 73210 Fax: (0586) 581 45





Bofors smoke shell, standard



Bofors smoke shell, IR



Bofors smoke shell, ER

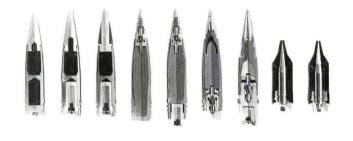
SWITZERLAND

Oerlikon-Contraves Ammunition

35 mm (35 mm × 228)

This 35 mm fixed ammunition is used in the Oerlikon-Contraves KD series of cannon installed in the Gepard, Caesar and Marksman twin 35 mm selfpropelled anti-aircraft gun systems, Oerlikon-Contraves GDF twin 35 mm towed anti-aircraft gun systems and Oerlikon-Contraves turrets. This ammunition is also compatible with the McDonnell Douglas Helicopter 35 mm Bushmaster III cannon currently under development.

Oerlikon-Contraves have recently expanded the 35 mm ammunition family further with the FAPDS (Frangible Armour-Piercing Discarding Sabot) round. This sub-calibre ammunition is equally effective in air defence as an HEI and in the defeat of light armoured vehicles. The terminal effectiveness is given by its kinetic energy.





Oerlikon-Contraves 35 mm projectiles, from left TP, TP-T, SRTP-T, HEI, HEI-T, HEI (base fuze), SAPHEI-T, FAPDS and APDS-T

SPECIFICATIONS NATO DESIGNATION WEIGHT	TP	TP-T	SRTP-T	HEI	HEI-T	SAPHEI-T	FAPDS	APDS-T
projectile	550 g	550 g	545 g	550 g	535 g	550 g	375 g	380 g
complete round	1580 g	1580 g	1575 g	1580 g	1565 g	1580 g	1440 g	1445 g
LENGTH (complete round)	387 mm	340 mm	340 mm					
MUZZLE VELOCITY	1175 m/s	1440 m/s	1440 m/s					
FLIGHT TIME								
to 1000 m	0.96 s	0.96 s	0.99 s	0.96 s	0.96 s	0.96 s	0.73 s	0.73 s
to 2000 m	2.18 s	2.18 s	2.38 s	2.18 s	2.18 s	2.18 s	1.54 s	1.52 s
to 3000 m	3.80 s	3.80 s	4.41 s	3.80 s	3.80 s	3.80 s	2.44 s	2.38 s
to 4000 m	6.06 s	6.06 s	7.40 s	6.06 s	6.06 s	6.06 s	3.45 s	3.34 s

30 mm (KCB) (30 mm × 170)

This fixed 30 mm ammunition is fired by the KCB cannon (previously HS 831) installed in the Oerlikon-Contraves Twin 30 mm GCM-AO3 naval anti-aircraft gun, French AMX-13 and AMX-30 DCA self-propelled anti-aircraft guns.

NATO DESIGNATION WEIGHT	TP	TP-T	HEI	HEI-T	SAPHEI
projectile complete round	360 g 870 g				
LENGTH (complete round) MUZZLE VELOCITY	285 mm 1080 m/s				
to 1000 m	1.08 s				
to 2000 m to 3000 m	2.61 s 4.93 s	2.56 s 4.83 s	2.61 s 4.93 s	2.56 s 4.83 s	2.61 s 4.93 s

Oerlikon-Contraves 30 mm projectiles from left: TP, TP-T, HEI, HEI-T and SAPHEI



25 mm (KBA) (25 \times 137) and other NATO approved 25 mm Cannon

This fixed 25 mm ammunition is used in the 25 mm KBA series cannon installed in the Oerlikon-Contraves GBD series of turrets and the Oerlikon-Contraves 25 mm GBI and GBM anti-aircraft guns. In addition this ammunition is compatible with the McDonnell Douglas 25 mm M242 Chain Gun.

NATO DESIGNATION WEIGHT	TP-T	TPDS-T	HEI-T	SAPHEI	FAPDS	APDS-T
projectile	180 g	150 g	180 g	180 g	150 g	150 g
complete round	500 g	486 g	500 g	500 g	480 g	486 g
LENGTH (complete						
round)	223 mm					
MUZZLE VELOCITY	1100 m/s	1335 m/s	1100 m/s	1100 m/s	1335 m/s	1335 m/s
FLIGHT TIME						
to 1000 m	1.18 s	0.98 s	1.18 s	1.18 s	0.80 s	0.80 s
to 2000 m	3.33 s	2.99 s	3.33 s	3.33 s	1.70 s	1.70 s

Oerlikon-Contraves 25 mm KBA projectiles from left: TP-T, TPDS-T, HEI-T. SAPHEI-T, FAPDS and APDS-T



25 mm (KBB) (25 mm × 173) (25 mm × 181)

This fixed 25 mm ammunition is fired by the Oerlikon-Contraves Type KBB cannon and used by the Seaguard CIWS.



Oerlikon-Contraves 25 mm KBB ammunition from left: TP, TP-T, TPDS-T, HEI, FAPDS, AMDS and APDS-T

NATO DESIGNATION WEIGHT	TP	TP-T	TPDS-T	HEI	FAPDS	AMDS	APDS-T
projectile complete round LENGTH (complete	230 g 600 g	230 g 600 g	190 g 570 g	230 g 600 g	230 g 600 g	190 g 570 g	190 g 570 g
round) MUZZLE VELOCITY FLIGHT TIME	288 mm						
	1160 m/s	1160 m/s	1285 m/s	1160 m/s	1160 m/s	1270 m/s	1285 m/s
to 1000 m	1.00 s	1.00 s	0.94 s	1.00 s	0.93 s	0.84 s	0.82 s
to 2000 m	2.42 s	2.42 s	2.46 s	2.42 s	2.00 s	1.81 s	1.74 s

20 mm (KAA/KAB) (20 mm × 129)

This fixed 20 mm ammunition is used by a wide range of weapons including the 20 mm Oerlikon-Contraves gun turret GAD and the following Oerlikon-Contraves 20 mm automatic anti-aircraft guns: GAI-D01, GAI-C01, GAI-C03, GAI-C04 and GAI-B01. The same projectiles, assembled with 20 \times 139 mm cartridge case can also be used in cannon KAD (HS 820), Rh 202. M693 and F2.



Oerlikon-Contraves 20 mm ammunition from left: TP, TP-T, HEI, HEI-T. HEI, SAPHEI, SAPHEI-T and API-T

SPECIFICATIONS NATO DESIGNATION WEIGHT	TP	TP-T	HEI	HEI-T	HEI	SAPHEI	SAPHEI-T	API-T
projectile	125 g	125 g	128 g	125 g	128 g	125 g	125 g	128 g
complete round	350 g	345 g	350 g	345 g	350 g	345 g	345 g	350 g
LENGTH (complete round)	203.8 mm							
MUZZLE VELOCITY								
KAA	1050 m/s							
KAB	1100 m/s							
FLIGHT TIME (to 1000 m)								
KAA	1.21 s							
KAB	1.14 s							
FLIGHT TIME (to 2000 m)								
KAA	3.24 s							
KAB	3.05 s							

20 mm (HS 804) (20 mm × 110)

This 20 mm ammunition is used in Oerlikon-Contraves 20 mm cannon. The completely redesigned Oerlikon-Contraves types are, according to the company, fulfulling all relevant military standards regarding safety.

SPECIFICATIONS NATO DESIGNATION WEIGHT	TP-T	HEI	HEI-T	API-T
projectile complete round	122 g 242 g	122 g 245 g	122 g 245 g	113 g 239 g
LENGTH (complete round)	184 mm	184 mm	184 mm	184 mm
MUZZLE VELOCITY FLIGHT TIME	830 m/s	850 m/s	830 m/s	965 m/s
to 1000 m	1.51 s	1.63 s	1.63 s	1.33 s
to 2000 m	3.98 s	4.56 s	4.56 s	3.72 s









Oerlikon-Contraves 20 mm ammunition from left: TP-T, HEI, HEI-T, and API-T

Oerlikon-Contraves APFSDS-T Ammunition

The original US Bushmaster specification required that the 25 mm cannon fired an APDS round which would penetrate 25 mm of armour at an angle of 60° NATO at a range of 1000 m. This utilised a spin-stabilised projectile.

Oerlikon-Contraves are now developing 35 mm and 25 mm fin-stabilised APFSDS-T projectiles which have greater penetration characteristics and faster times of flight.

PERFORMANCE

Туре	Muzzle velocity	Time to 1000 m	Time to 2000 m	Time to 3000 m	Time to 4000 m
25 mm KBA M242	1405 m/s	0.75 s	1.57 s	2.51 s	n/a
25 mm KBB	1200 m/s	0.88 s	1.85 s	2.94 s	4.17 s
35 mm	1400 m/s	0.75 s	1.57 s	2.49 s	3.50 s



Oerlikon-Contraves APFSDS-T projectile

Oerlikon-Contraves AHEAD Anti-aircraft Ammunition to **Defeat Missiles**

A new generation of ammunition known as AHEAD is being developed by Oerlikon-Contraves as a private venture to expand the defensive capability of medium calibre air defence guns in response to the growing threat from precision guided munitions, missiles and other high technology weapons.

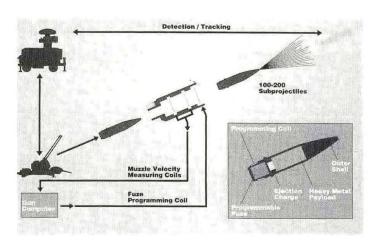
AHEAD stands for Advanced Hit Efficiency And Destruction and is the code-name given by Oerlikon-Contraves to a new family of heavy metal payload, programmable fuze heavy metal ammunition for air defence guns.

Currently in its final development phase, the AHEAD type ammunition is scheduled to become available in 35 mm calibre in the mid-1990s.

The AHEAD projectile consists of a heavy metal payload shell with a programmable base fuze. The shell is filled with an ejection charge. The heart of the fuze is an advanced high precision timer that will set off the charge according to its programming.

Programming of the timer is achieved at the muzzle velocity gauge as the projectile leaves the muzzle. The gauge consists of three coils. While the projectile passes through the first two coils its exact velocity is determined and processed with target information as supplied by the fire-control computer.

The exact projectile flying time is calculated and imparted to the fuze by electro-induction as the projectile passes through the third coil. As a result, the time fuze will accordingly detonate the ejection charge at a given distance in front of the target, forming a cone of heavy metal sub-projectiles and directing it into the target.

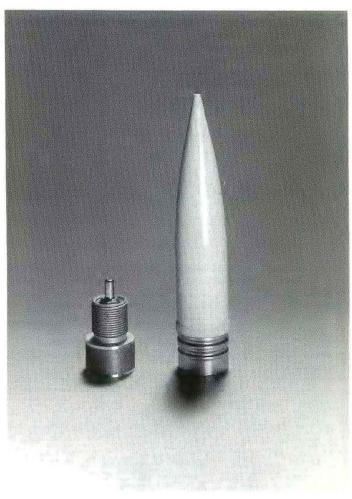


AHEAD schematic with Skyguard fire-control system and twin 35 mm towed anti-aircraft gun system

Through their high kinetic energy these sub-projectiles are capable of defeating any missile drone or RPV whatever front-end armour they have. according to Oerlikon-Contraves.

Manufacturer: Oerlikon-Contraves AG, Pyrotec, Birchstrasse 155, CH-8050 Zürich, Switzerland.

Telephone: (01) 316 44 14 Telex: 755200 WOB CH Fax: (01) 311 74 79



AHEAD projectile (right) with muzzle programmable electro-induction fuze (left) detached

TAIWAN

Hsing Hua Ammunition

The Hsing Hua Company manufactures the following types of ammunition of American design for both the home and export markets:

Calibre	Application
40 mm	for L/60 Bofors LAAG and M42 SPAAC
75 mm	for M116 pack howitzer
76 mm	for M41 tank
90 mm	for MAZ and MAR tanks

Calibre Application 105 mm for M101 and M102 towed howitzer and M52 and M108 self-propelled howitzers 155 mm for M114 and M198 towed howitzers and M109 and M44 self-propelled howitzers (also propelling charges) 155 mm for M59 gun (also propelling charges) 203 mm for M115 towed and M55 and M110 self-propelled howitzers (also propelling charges).

Manufacturer: Hsing Hua Company Limited, PO Box 8746, Taipei, Taiwan.

TURKEY

MKEK Ammunition

Makina ve Kimya Endüstrisi Kurumu (MKEK) is the biggest industrial organisation in Turkey. Its General Directorate is in Ankara along with seven factories; other factories are located around Turkey. MKEK military products include small arms and small arms ammunition, commercial explosives, mortars and mortar ammunition, fuzes, mines, rockets and aircraft bombs. Artillery ammunition produced includes the items in the table opposite:

Calibre	Type
35 mm	HEI and TP-T
105 mm	HE M1
105 mm	APFSDS-T FP105, HE MKE-MOD 233, PRAC MKE-MOD 234
106 mm	HEAT-T M344A1
155 mm	HE M101, HE M107
175 mm	HE MKE-MOD 111
203 mm/8 in	HE M106
5 in/38	HE MKE MOD 205, TP MKE MOD 202

Propellant charges are also produced for 90 mm tank guns, 105 mm howitzers, 106 mm recoilless rifles, 5 in naval guns, 155 mm howitzers and guns and 203 mm/8 in howitzers.

In mid-1984, after evaluating a number of 105 mm APFSDS rounds for its M48A5 and Leopard 1 MBTs, the Turkish Government awarded a contract valued in excess of \$30 million to the former Flinchbaugh Division of the American General Defense Corporation, for the supply of 105 mm FP105 rounds.

The contract covered a period of 36 months and included the supply of complete rounds of ammunition, parts for final assembly in Turkey and equipment and tooling for Turkey's Makina ve Kimya Endüstrisi Kurumu to

undertake production of the complete round. The contract also covered the transfer of technology and the establishment of a testing range. The programme has been agreed to by the Turkish MoD in conjunction with the United States Government's Improvement and Modernisation Programme.

Other products currently being manufactured in MKEK's facilities include anti-aircraft guns, 105 mm tank barrels for locally modified M48 series MBTs and 155 mm howitzer barrels for the M44T self-propelled howitzer.

Manufacturer: Makina ve Kimya Endüstrisi Kurumu, Ankara, Turkey. Telephone: (90-4) 223 20 11 Telex: 42 223 MKGA TR Fax: (90-4) 223 01 40-222 22 41

UNITED KINGDOM

Royal Ordnance Ammunition

120 mm Tank Gun Ammunition

This ammunition is designed for use in the 120 mm L11 rifled tank gun which is mounted on the Challenger 1 and Chieftain MBTs in service with the British armed forces, it is also supplied to several overseas customers. For this ammunition, the projectile and propelling charge are loaded separately. The charge consists of stick propellant either in a calico bag or in a rigid combustible case. Bag-type igniters are attached to the bases of the calico bags and inserted in the bases of the combustible cases. Ignition is by means of an electric vent tube which is loaded into a magazine in the vent tube loader attached to the rear face of the breech ring. The tube is fired by means of an electric firing needle.

APFSDS (L23) has replaced APDS as the main tank gun round for the attack of armour. The projectile consists of a long-rod penetrator of dense tungsten alloy which is stabilised during flight by aluminium fins. The high muzzle velocity and flat trajectory give a short time of flight and a high probability of a first round hit. APFSDS is capable of defeating all current main battle tanks at normal combat ranges.

APDS (L15) is able to defeat all but the latest tank armour. The projectile consists of a sub-projectile containing a dense tungsten alloy core mounted in a light alloy sabot.

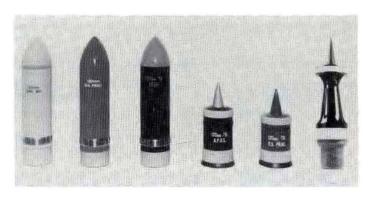
DS (L20) Practice is used in training to represent APFSDS and APDS. It is less expensive than the service rounds and has the benefit of a smaller safety trace for use on ranges.

HESH (L31) is a general-purpose high explosive round fitted with a base fuze. As well as having good anti-armour performance it is particularly effective against concrete fortifications, buildings, soft vehicles and against troops in the open or under light cover.

Smoke (L34) consists of a bursting type of shell filled with white phosphorus and fitted with a base fuze. It produces a dense white smoke screen very rapidly. The shell is designed to have the same ballistic characteristics as HESH

SH/Practice (L32) is the training round for the HESH and Smoke and consists of an inert shell filled with HE substitute. The most common version is entirely inert but designs are also available in which a live fuze is fitted together with a flash pellet to give a good visible indication of the point of impact.

Charge System. Until recently bag charges were supplied for all types but Combustible Case Charges (CCCs) are now available for use with APFSDS, APDS and DS PRAC projectiles. These CCCs appreciably increase barrel life, improve ignition regularity and make handling easier.



From left to right: Royal Ordnance 120 mm L34 Smoke WP, L32 SH/PRAC, L31 HESH, L15 APDS, L20 DS PRAC and L23A1 APFSDS

Enhanced 120 mm Ammunition

For operations in the Middle East during Operation Granby/Desert Storm, Royal Ordnance improved the fire-power of the Challenger 1 fleet with a new projectile and charge system.

The new APFSDS projectile gave greater accuracy and penetration and is believed to incorporate features of the new system being developed for Challenger 2 which will also be backfitted to Challenger 1s in the future.

It is believed that the APFSDS projectile is designated the XL26E1 with the charge being the L14A1. The Royal Ordnance code word for this project was Jericho.

New 120 mm Ammunition

Currently in production at Royal Ordnance Nottingham is the 120 mm L30 rifled tank gun. This is installed in the prototypes of the Challenger 2 MBTs and is being backfitted into the existing Challenger 1 MBTs of the British Army. Details of the L30 are given on page 31 of this edition.

The L30 will fire existing natures of 120 mm Royal Ordnance ammunition with the exception of the APDS projectile.

The L30 fires a new APFSDS L26 projectile with a depleted uranium penetrator which has enhanced penetration characteristics over the current in service L23 projectile and a new stick charge propellant system. The first DU projectile forms part of the CHARM 1 system but under development is the CHARM 3 DU projectile with even better penetration characteristics.

SPECIFICATIONS Type CHARGE DESIGNATION CHARGE CONTAINER TYPE WEIGHT	HESH L31 L3 Bag	APDS L15 L4 Combustible Case	SMOKE L34 L3 Bag	SH PRAC L32A6 L3 Bag	DS PRAC L20A1 L5 Combustible Case	APFSDS L23 L8 Combustible Case
projectile propellant (nominal) PROPELLANT TYPE MUZZLE VELOCITY	17.86 kg 3.04 kg NQ/S27-09 670 m/s	10.36 kg 8.4 kg NQ/S53-12 1370 m/s	17.36 kg 3.04 kg NQ/S27-09 670 m/s	17.1 kg 3.04 kg NQ/S27-09 670 m/s	5.82 kg 5.16 kg NQ/S27-09 1370 m/s	7.89 kg 6.65 kg AX/S64-20

105 mm Tank Gun Ammunition

This has been designed to be fired from the 105 mm L7 series rifled tank gun which is fitted to many current MBTs such as the Leopard 1, Vickers Mk 1 and 3, M60, early M1, updated M48, Merkava and regunned T-54 series. The ammunition is available as a complete system and includes both kinetic and chemical energy rounds. All are fixed rounds with the projectiles attached to a brass cartridge case containing the propellant and electric primer.

APFSDS is the main 105 mm anti-armour round. It consists of a long-rod, monobloc penetrator of dense tungsten alloy which is stabilised in flight by an extruded aluminium alloy fin. The penetrator is mounted in a light alloy sabot and the high velocity and flat trajectory increases accuracy. The first-generation APFSDS round, the L64, is being replaced by the H6/62 which uses the same charge as the L64 but features a completely new projectile.

The penetrator is manufactured from the latest tungsten-nickel-iron alloy and the nose is designed to provide the round with a high lethality against the latest target arrays.

The H6/62 is capable of horizontal and vertical accuracy (standard deviation) of better than 0.3×0.3 mils out to 3000 m when fired at temperatures of -46 to +52°C from barrels with varying states of barrel wear up to condemnation and at rates of fire of up to five rds/min.

The penetrator is 25 mm in diameter with the fin being a six-bladed aluminium extrusion. Service chamber pressure is 4260 bar, maximum chamber pressure is 5110 bar and barrel wear is 380 rounds at +21°C. Muzzle velocity at +21°C is 1480 m/s. The 105 mm L63 DS PRAC training round matches the H6/62 trajectory at 2000 m using the same sighting equipment.



DS Practice provides a less expensive practice round representing APFSDS and APDS. It consists of a steel projectile with a light alloy nose and is mounted in a sabot similar to the APDS. This round matches the APDS ballistically up to 1100 m, and matches the APFSDS trajectory at 2000 m using the same sighting equipment. It has little penetrative effect and a much smaller safety trace on the ranges.

HESH is a general-purpose round with a thin-walled blunt nose and is filled with a rapidly detonating high explosive initiated by a base fuze. It is effective against a wide variety of battlefield targets.

SH Practice is an inert practice round for training purposes. It has the same empty body as the HESH, but is filled with an inert HE substitute. In the most common version the SH PRAC is fitted with a base fuze together with a flash pellet to give a good visible indication of point of impact, but designs are available for an entirely inert projectile.

Smoke BE round uses a base ejection shell. A time fuze ignites and ejects three canisters filled with a smoke mixture which fall to the ground burning and discharging dense clouds of smoke for 50 seconds.

Royal Ordnance 105 mm H6/62 APFSDS projectile with sabot

SPECIFICATIONS Type WEIGHT	APFSDS H6/62	APFSDS L64	APDS L52	DS PRAC L63	HESH L35	SH PRAC L38	Smoke BE L39
complete round	18.5 kg	18.5 kg	19.25 kg 6.48 ka	14.91 kg 3.91 ka	21.23 kg 11.26 ka	21.23 kg	26.37 kg
projectile propellant (nominal) PROPELLANT TYPE	6.05 kg 5.62 kg LM 1900	6.05 kg 5.62 kg LM 1900	5.6 kg NQ/M12	3.97 kg 3.97 kg NQ/M07	2.81 kg NH08	11.26 kg 2.81 kg NH08	19.6 kg 0.4 kg WM04



Royal Ordnance 105 mm tank ammunition, from left to right, APFSDS H6/62, APFSDS L64, APDS L52, DS PRAC L63, HESH L35, SH/PRAC L38 and Smoke BE L39

105 mm APFSDS Round for IWS

For use with the private venture 105 mm Improved Weapon System (IWS) fully covered in the *AFV Armament* section, Royal Ordnance has developed a new APFSDS round. This cannot be fired from existing 105 mm L7 or M68 rifled tank guns.

This round has been designed to operate at increased pressure levels and incorporates a new heavy tungsten alloy penetrator which has been designed to give a major improvement in armour penetration capability over existing 105 mm APFSDS ammunition fired from standard pressure 105 mm tank guns. No details of performance have been released but Royal Ordnance claim that the round has a penetration performance comparable with in-service 120 mm smooth-bore rounds.

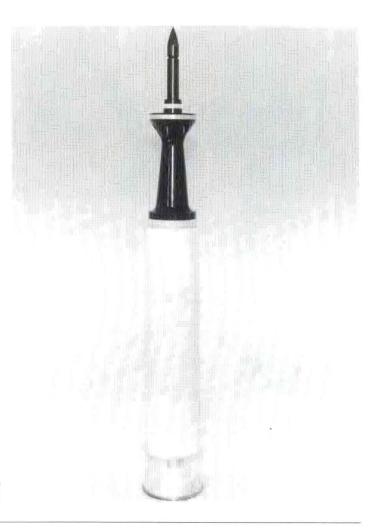
The IWS APFSDS round is of the fixed type with an overall length of 1030 mm with the projectile comprising a Tungsten-Nickel-Iron penetrator located in a three segment sabot that has been designed to reduce parasitic weight to the minimum.

The penetrator has a high length to diameter ratio and a mass approximately 40 per cent greater than current 105 mm APFSDS rounds.

The propelling charge comprises a stub case and a combustible sleeve which together house the multibase propellant and primer.

SPECIFICATIONS

CALIBRE	105 mm
LENGTH (complete round)	1030 mm
WEIGHT (complete round)	19 kg
MUZZLE VELOCITY	1420 m/s



Royal Ordnance 105 mm APFSDS round for Royal Ordnance Improved Weapon System

Royal Ordnance 155 mm Ammunition System

In June 1986 Royal Ordnance announced that it was developing, as a private venture, the Royal Ordnance 155 mm Ammunition System which consisted of four items covering HE requirements in all zones out to 30 000 m. The system has two projectiles, RO24 and RO30 and two charges RO79 and RO109. The Royal Ordnance Ammunition System is compatible with most 39 calibre gun systems including the M109 series, M198, M114/39, FH-77B, FH-70, GBT 155, M139 (Netherlands), M71 and AS90. Ranges are as follows:

Projectile	Charge	US Zone	Max muzzle velocity	Max Range
RO24	RO79	3-8	684 m/s	19 800 m
RO24	RO109	8 Super	827 m/s	24 700 m
BO30	RO109	8 Super	827 m/s	30 000 m

The RO24 is a high fragmentation/low drag projectile designed for hot and cold climates and is available with TNT or RDX/TNT filling. It can be fitted with the L106 or multirole fuze and has a range of 3000 m to 24 700 m using RO70 and RO109 charges.

RO30 is ballistically matched to RO24 but incorporates an RO Base Bleed system, it is filled with TNT or RDX/TNT and can be fitted with the L106 or multirole fuze. Using the RO109 charge ranges in excess of 30 000 m have been achieved. There are also the 155 mm practice flash projectiles which reach 10 000 m using RO79 increment five and are ballistically matched to service rounds (M107 or L15). These low cost training projectiles are fitted with screw-in impact indicators to signify fall of shot.

Royal Ordnance 79 has five increments consisting of a triple-base RO stick propellant in an RO compatible sleeve. The base igniter is incorporated with the lowest increment.

RO109 is a stand-alone charge covering US zone 8 super and consists of an RO stick propellant in an RO combustible charge container. The base igniter is incorporated with the combustible container which contains wear reducing additives. The charge itself includes anti-wear additives.

As a private venture, Royal Ordnance is developing a Unimodular 155 mm charge system based around six modules, each of the same propellant type and charge weight.

Status: In production.



155 mm FH-70 Ammunition

Royal Ordnance is one of the manufacturers of a family of 155 mm ammunition which has been specially designed trilaterally by the UK, FRG and Italy for the FH-70, giving a significant increase in range and lethality against all types of target.

In 1986 Royal Ordnance shipped 9000 rounds of L15 HE ammunition to Japan with a further 21 000 rounds following in 1987. Japan has now established a production facility for the L15 round in Japan. This is fired by the Japanese FH-70 systems. Total value of this contract, which also covered propelling charges and a quantity of standard charges for ammunition proofing was £20 million.

HE is a thin-walled shell with a high fragmentation effect and a very high explosive capacity and is fitted with a nose fuze which can be set to explode on impact or after a short delay. The advanced filling technique employed in the production of this shell ensures that safety from premature functioning is achieved at the highest charge.

Charge System is an eight zone system with a triple-based propellant. The system is divided into three separate cartridges as shown below. The charge system is ballistically balanced, has a clean combustion and is initiated by a percussion igniter tube.

Charge System CARTRIDGE 1	Range			
increment 1	2500-410	0 m		
increment 2	3900-590	0 m		
CARTRIDGE 2				
increment 3	4800-750	0 m		
increment 4	6200-950	0 m		
increment 5	8500-12 5	500 m		
increment 6	11 200-16	800 m		
increment 7	14 200-20	0 900 m		
CARTRIDGE 3				
increment 8	17 000-24	4 000 m		
_				
Туре	HE L15	Cart 1 L2	Cart 2 L8	Cart 3 L10
WEIGHT				
projectile	43.5 kg	_	_	_
explosive	11.32 kg	-	_	_
propellant (nominal)	_	1.21 kg	7.55 kg	12.48 kg
PROPELLANT TYPE	_	SC/Z.02	N.06	N/S 54.14



155 mm L15 HE projectile for FH-70

105 mm Light Gun Artillery Ammunition

105 mm FD Ammunition is designed for use with the Abbot self-propelled gun and the 105 mm Light Gun. All rounds are of the separate loading type in which the propelling charge contained in a brass cartridge case is loaded into the gun after the projectile. The propelling charge can be easily adjusted to give the required range and is initiated by an electric primer.

N/S 30.10

HE is the standard projectile used by artillery or the close support of infantry. It is fitted with a nose fuze which can be set to explode on impact or after a short delay to allow penetration of the target before detonation. A mechanical time fuze is also available to burst the shell in the air.

Optimum performance is obtained from the shell by using a high tensile steel body and explosive of the highest power commensurate with the safety from premature functioning. The lethal area of this shell is 25 per cent greater than with the American M1 shell.

Smoke BE shell has a cylindrical cavity in which are mounted three smoke canisters. These are ejected at the required point in flight by a mechanical or electronic time fuze and fall to the ground discharging dense clouds of smoke for 60 seconds

Marker (Coloured Smoke) shells burst on the ground and are used to mark a position such as a target for an air strike. Red and orange smoke

Illuminating shell is a Swedish Bofors design and provides one million candle power for 15 to 20 seconds.

Charge System has three types of charge. The first, the Cartridge Normal, consists of a six-zone system which can be easily adjusted to obtain the required range. The Cartridge Super is a fixed charge. A Training Cartridge is also available and consists of increments 1, 2 and 3 only. All types are contained in a brass cartridge case. The minimum ranges in high angle for increments 1 and 2 are achieved by fitting spoilers to the shell.

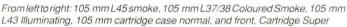
In mid-1986 it was announced that a base bleed 105 mm round was under development and this had already been fired to a range of over 22 000 m. Early in 1993, development work on this projectile was continuing.

DATA	
Charge System	Range
NORMAL AND TRAINING	
CARTRIDGES	
charge 1*	2500-5700 m
charge 2*	2700-7200 m
charge 3	5900-9500 m
NORMAL CARTRIDGE	
charge 4	7900-12 200 m
charge 41/2†	8700-13 600 m
charge 5	15 300 m (max)
SUPER CARTRIDGE	17 200 m (max)

- * The minimum ranges in high angle for charges 1 and 2 are achieved by fitting spoilers to the shell
- † Increments 1, 2 4 and 5

SPECIFICATIONS Type	HE-L31	Smoke-L45	ILL-L43	Marker-L37/38	Cartridges Normal-L35	Super-L36	Training L45
WEIGHT projectile propellant (nominal) PROPELLANT TYPE	16.1 kg	15.56 kg	16.1 kg	16.1 kg	2.4 kg N.04 N/S 31-11 N/S 42-12	2.86 kg N/S 42-12	0.89 kg N.04







105 mm field artillery L31 HE projectile

Royal Ordnance Flash Indicating Shell

Marketing by Royal Ordnance indicated that there was a requirement for realistic training for all gun battery members (gun crew, forward observers and fire-control centre). Training with existing high explosive projectiles is not only expensive but requires large safety areas and its effect is environmentally damaging through blast and toxic hazards. Even inert filled projectiles suffer from the drawback in that they do not give an indication of fall of shot.

The solution to this problem, according to Royal Ordnance, is the Royal Ordnance Flash Indication Shell (ROFIS). This is manufactured from proven materials, internal and external ballistics are matched to the parent HE projectile, visual indication of fall of shot at greater than 4000 m in clear daylight conditions and at night, reduced safety template similar to inert projectile, reduced magazine storage requirement as the projectile body and impact indicator are delivered separately, simple assembly of the shell as required for firing, negligible environmental damage, unit cost significantly lower than HE or inert filled shell and realistic training for all gun battery members.

SPECIFICATIONS

Shell, 105 mm, How, Practice Flash Indicating, RO 38-05 A1

BALLISTIC EQUIVALENT

L31A3

L118 or equivalent

RANGE

9500 m

CHARGES

STATUS

L35A2 (up to increment 3) L45A1 training (all increments)

In production

Shell, 155 mm, How, Practice Flash Indicating, RO 18-05 A1

BALLISTIC EQUIVALENT M107 **GUNS**

L121 (FH-70) or equivalent RANGE 12 300 m

CHARGES M3A1 (all zones)

M4A2 (to zone 6W) L2A1 (all charges)

L8A1 (to charge 4)

STATUS Development complete

Shell, 155 mm, Practice Flash Indicating, RO 24-05 A1

BALLISTIC EQUIVALENT L15A2

GUNS L121 (FH-70) or equivalent RANGE 12 400 m

CHARGES M3A1 (all zones) M4A2 (to zone 6W)

L2A1 (all charges) L8A1 (to charge 4)

STATUS In production. Accepted for service by UK

MoD

Royal Ordnance 90 mm Ammunition

Late in 1990 it was announced that Royal Ordnance had signed an exclusive agreement with Cockerill Mechanical Industries of Belgium, under which Royal Ordnance would manufacture a full range of ammunition for the 90 mm Cockerill guns. This ammunition was previously made by PRB of Belgium.

SPECIFICATIONS						
Туре	RO designation	Previous PRB designation	Weight (complete round)	Type of filling	Length (complete round)	Max muzzle velocity
HEAT-T	RO 907	NR 478	7.3 kg	RDX/TNT	651 mm	890 m/s
HEAT-TP-T	RO 940	NR 479	7.3 kg	Inert	651 mm	890 m/s
HESH-T	RO 929	NR 503	7.7 kg	RDX/Wax	591 mm	800 m/s
APFSDS-T	RO 964	NR 232	6.3 kg	n/a	595 mm	1050 m/s
HE-T	RO 924	NR 501	8.5 kg	TNT	635 mm	700 m/s
HE-TP-T	RO 911	NR 558	8.5 kg	Inert	635 mm	700 m/s
HE-APERS-T	RO 925	NR 219	11.0 kg	TNT	675 mm	330 m/s
Smoke-WP-T	RO 932	NR 502	8.8 kg	WP	635 mm	695 m/s
Canister	RO 933	NR 125	6.2 kg	Balls	355 mm	490 m/s

76 mm Ammunition

The 76 mm ammunition system was designed for the L5 gun fitted to the Saladin armoured car. It is now used with the L23 gun which is the lightweight weapon fitted in the Scorpion light tank. The ammunition is available as a complete system and all are fixed rounds with the projectiles attached to a brass cartridge case containing the propellant and percussion

HESH is the general-purpose anti-hard target high explosive round with a thin-walled blunt nose, it is filled with a rapidly detonating high explosive initiated by a base fuze. It is effective against armour, concrete fortifications, buildings and soft vehicles and against troops in the open or under light cover. This round also has a very good graze performance. A modified HESH round for removing excess copper from the barrel rifling is also available.

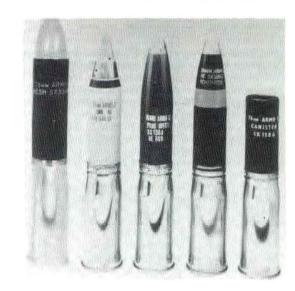
SH/PRAC is an inert round available for training purposes. The most common version is entirely inert, but designs are also available in which a live fuze is fitted together with a flash pellet to give a good visible indication of point of contact.

HE round is an anti-soft target round designed for the general support of infantry. It is fitted with a nose fuze which explodes on impact and optimum performance is obtained by using a high tensile steel for the shell body which bursts into the maximum number of fragments moving at a high velocity.

An inert round (HE/PRAC) is available for training purposes.

Smoke BE is a base ejection smoke round fitted with a time fuze which ejects three canisters at a selected point in flight. These fall to the ground emitting dense clouds of smoke for 50 seconds.

Illuminating contains a star case and parachute in a modified smoke shell. The time fuze ejects the flare at the appropriate elevation which then burns suspended from the parachute providing illumination for a minimum of 30 seconds.



From left to right: 76 mm L29 HESH, L32 Smoke BE, L25 HE/PRAC, L24 HE and L33 Canister

Canister is used for engaging massed infantry attack at close quarters and consists of a thin-walled cylindrical body filled with steel pellets. The pellets spread out after leaving the gun muzzle and are highly lethal to a range of about 100 m.

SPECIFICATIONS Type	HESH L29 De-coppering L44 SH/PRAC L40	HE L24 HE/PRAC L25	Smoke BE L32	Illuminating L42	Canister L33
WEIGHT					
complete round	7.41 kg	7.35 kg	10.21 kg	9.62 kg	6.76 kg
projectile(s)	5.39 kg	5.37 kg	8.53 kg	7.1 kg	4.71 kg
propellant (nominal)	0.61 kg	0.57 kg	0.27 kg	0.27 kg	0.64 kg
PROPELLANT TYPE	NQ/M07	NQ/M07	FNH/M04	FNH/M04	FNH/M04

30 mm RARDEN Ammunition

This ammunition is designed to be fired by the 30 mm RARDEN cannon (L21A1), installed in the CVR (W) Fox and CVR (T) Scimitar armoured vehicles, in a Fox turret mounted on a small number of FV432 APCs and also in the GKN Defence Warrior mechanised combat vehicle which entered service with the British Army in 1987. The RARDEN cannon will also fire the Oerlikon-Contraves range of 30 mm KCB ammunition.

SPECIFICATIONS Type	APSE-T	HEI-T	TP-T
BRITISH ARMY DESIGNATION	L5A2	L13A1	L12A1
WEIGHT complete round	904.4 g	903.9 g	903.9 g
projectile	357.4 g	356.9g	356.9 g
filling propellant	29 g 160 g	25.6 g 160 g	26.5 g 160 g
FILLING TYPE	CS5390	Torpex 2	Inert
PROPELLANT TYPE	NRN 141/RDN	NRN 141/RDN	NRN 141/RDN
LENGTH (complete round) MUZZLE VELOCITY	285.55 mm 1070 m/s	285.55 mm 1070 m/s	285.55 mm 1070 m/s

Range table (max range is 10 200 m)			
Range	Elevation mils	Flight time	Residua velocity
400 m	2.0	0.39 s	976 m/s
1000 m	5.5	1.08 s	820 m/s
2000 m	13.7	2.59 s	585 m/s
3000 m	27.4	4.7 s	394 m/s
4000 m	51.4	7.71 s	300 m/s



30 mm ammunition for RARDEN cannon: HEI-T, APSE-T and TP-T

RARDEN APDS Ammunition

The RARDEN 30 mm APDS round, now in service with the British Army, was developed jointly by Royal Ordnance and PATEC of the USA.

The round is designated the L14A2 and is recognisable by the lateral cross-section at the nose. It can penetrate 40 mm of RHA at an incidence of 45° at ranges in excess of 1500 m. Once the round has been fired the sabot breaks up into four lateral segments and the tungsten penetrator has a base tracer element that will burn to ranges in excess of 2000 m. To aid result assessment the penetrator has a pyrophoric nosecap giving a visual indication of a hit on a hard target. The accuracy of the projectile is such that the APDS penetrator has approximately half the dispersion of current 30 mm HE ammunition.

Royal Ordnance is also able to supply realistic training ammunition which matches the APDS trajectory out to a range of 1500 m.

SPECIFICATIONS

DESIGNATION	APDS L14A2
CALIBRE	30 mm
WEIGHT	
projectile	300 g
cartridge case	365 g
complete round	822 g
MUZZLE VELOCITY	1175 m/s

BMARC Ammunition

In April 1992, Royal Ordnance agreed to acquire, from the receivers, the business of the British Manufacture And Research Company (BMARC) which, as a UK subsiduary of Astra Holdings, went into receivership in February 1992.

BMARC (Jane's Armoured Fighting Vehicle Retrofit Systems 1992-93 page 130) operated from two sites at Grantham and Faldingworth and



Clip of three Royal Ordnance 30 mm RARDEN APDS rounds (Henry Dodds)

manufactured a range of medium calibre guns and ammunition. In July 1992, a decision was taken to retain the Faldingworth site and transfer the majority of the weapons manufacturing work to Royal Ordnance Nottingham.

In October 1992, Royal Ordnance signed a new licence agreement covering a substantial part of the Oerlikon-Contraves range of medium calibre guns and ammunition. Details of Oerlikon-Contraves ammunition are given in this section under Switzerland.

Manufacturer: British Aerospace Defence Limited, Royal Ordnance Division, Euxton Lane, Chorley, Lancashire PR7 6AD, UK.

Telephone: +44 (257) 265511 Telex: 67441 Fax: +44 (257) 242199

UNITED STATES OF AMERICA

United States Artillery Fired Atomic Projectiles (AFAP)

These are now being withdrawn from service, details were given in *Jane's Armoured Fighting Vehicle Retrofit Systems 1992-93* pages 130/131.

American Ammunition Development

The Project Manager for Cannon Artillery Weapons Systems is at Dover, New Jersey, and is part of the United States Army Materiel Development and Readiness Command.

Cannon Artillery Weapon Systems has the responsibility for the development, engineering, procurement and successful fielding of all 155 mm weapons and equipment, it is also Joint Project Manager (Army and Navy) and executive agent for the development and production of all semi-active laser-guided projectiles. In addition it has responsibility for assuring interchangeability and interoperability of United States 155 mm weapons ammunition and propelling charges with Quadrilateral countries (USA, UK, Germany and Italy).

Weapons that are the responsibility of Cannon Artillery Weapons Systems are the 155 mm M198 and product improvements to the 155 mm M109 series of self-propelled howitzers.

Projectiles already developed and placed in production include:

155 mm M549A1 rocket-assisted projectile

155 mm M483A1 improved conventional munition which contains 64 M42 and 24 M46 dual-purpose grenades

M692 and M731 area denial artillery munitions each of which contains 36 anti-personnel mines

M718 and M741 remote area anti-mine systems, each of which contains nine anti-tank mines

155 mm M864 Dual-Purpose Improved Conventional Munition

In January 1978 the building of the Mississippi Army Ammunition plant began. This is capable of producing 120 000 155 mm M483A1 projectiles per month. The Mississippi was the first new army ammunition production plant to be built for more than 30 years. It was expected that the plant would be completed in December 1983 at a cost of approximately \$400 million but

it experienced numerous start-up problems and by early 1989 was not fully operational. Prior to this, in September 1986, the army reported deficiencies in plant processes and other problems had prevented the plant from meeting its design mobilisation production rate fully.

Congress provided \$123 million in FY87 funds to correct the identified deficiencies, subsequently a \$117.7 million firm fixed price contract was awarded to Mason Chamberlain Incorporated to correct the problems by 31 August 1990.

The US Army had planned to continue producing M483A1 rounds at the Mississippi plant following completion of the mobilisation contract but due to funding constraints it did not request FY90 funds to purchase additional M483A1 rounds and the army now plans to place the plant on a standby status following completion of the contract.

The M483A1 is the only projectile produced at the Mississippi plant, but the M483A1 itself is also produced at the GOCO plants at Milan and Kansas. The US Army has some 3.8 million M483A1 rounds, less than half the amount the army is authorised to procure. The 155 mm M864 projectile, to be produced at Scranton, Louisiana and Milan ammunition plants, is the replacement for the M483A1.

The US Army's ammunition production base includes 28 governmentowned ammunition plants located throughout the United States, 17 of which are in operation with the remaining 11 semi-active or on standby for possible use during mobilisation.

The Army awards contracts to the private sector for operating and maintaining its Government-Owned Contractor Operated (GOCO) ammunition plants. Such contracts are awarded for both active and inactive plants usually covering a five year period – one year with four optional years.

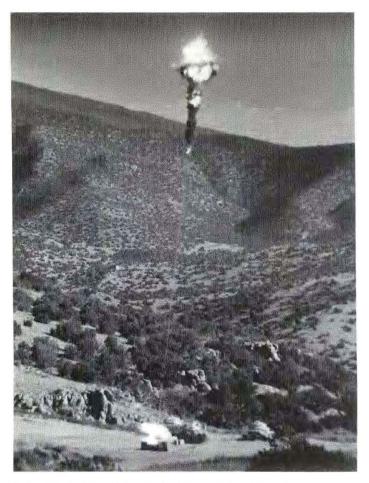
Sense And Destroy Armor Munition (SADARM)

The original concept for the Sense And Destroy Armor Munition (SADARM) can be traced back to the early 1960s but at that time the required technology was not available.

The basic idea was to use an M509 8 in (203 mm) projectile to carry a number of submunitions which would be dispensed over the target area where they would detect and attack the vulnerable tops of armoured vehicles.

The US Army's Research and Development Engineering Center (ARDEC), Dover, New Jersey, had overall responsibility for the development of SADARM. In October 1977 ARDEC solicited industry to develop a submunition for demonstration purposes and a request for quotations was issued.

In May 1978 Aerojet Electronic Systems was awarded an \$820 000



Early trial of SADARM showing MBT target being engaged

contract to develop a submunition for demonstration purposes. In February 1979 Honeywell (now Alliant Techsystems) made an unsolicited proposal to develop a submunition. The US Army subsequently negotiated a firm contract with Honeywell (now Alliant Techsystems) and both companies carried out a successful submunition demonstration in 1979.

In March 1980 the US Army formulated a programme acquisition strategy for SADARM and the following month a request for proposals was circulated to 17 contractors of which four, Aerojet Electronic Systems, AVCO, Honeywell (now Alliant Techsystems) and Singer Aerospace Marine Systems, submitted proposals. These were all evaluated and in September 1980 Aerojet Electronic Systems and Honeywell (now Alliant Techsystems) were awarded contracts valued at \$14 million and \$10 million respectively over a 38 to 42 month period.

In July 1982 a revised acquisition strategy was approved with both contractors to continue engineering development.

In March and April 1983 both contractors were asked to provide the estimated cost to complete the advanced development of SADARM under the revised acquisition strategy.

During 1983, however, the US Army decided to terminate the 8 in SADARM programme as there was then no requirement and Congress limited funding to a 155 mm version. Using remaining funding both contractors continued in order to provide as many data as possible, with Aerojet Electronic Systems firing a complete projectile with two submunitions in December 1984 and Honeywell (now Alliant Techsystems) firing two projectiles in April 1985.

In 1986 it was decided to develop SADARM for use with 155 mm howitzers such as the M109 series and Vought Multiple Launch Rocket System (MLRS).

In April 1986, 31 contractors were circulated for full-scale development of SADARM and three bids were received. In September 1986 the Defense Systems Group of Honeywell (now Alliant Techsystems) was awarded a contract with a total value of \$95.371 million and Aerojet Electronic Systems received a contract with a total value of \$87.209 million.

In May 1991, the US Army completed a downselect and stated that it would only proceed with the Aerojet Electronic Systems Division design for SADARM and terminate the competing contract with Alliant Tech systems.

Alliant Techsystems became a subcontractor to Aerojet Electronic Systems Division to complete the full-scale development programme and they jointly agreed to continue the business relationship as the programme proceeded into production.

Full-scale production is expected to commence in FY94 with a total of over 200 000 155 mm and MLRS SADARMs to be manufactured to fulfil the US Army counterfire requirement. There is a 90 per cent commonality between the 155 mm and MLRS designs with the MLRS submunition being about 25 mm larger than that of the 155 mm SADARM.

The MLRS is expected to hold six SADARMs while the 155 mm projectile will hold two.

The projectile or rocket is fired over the target area and SADARMs are dispensed from the rear of the projectile by a preset time fuze. Once out of the carrier projectile the submunition is despun and decelerated by a Ram Air Inflation Device (RAID). The electronics and sensor are then powered up and the MMW radar is put into a search mode to find a specific altitude. At this altitude, the RAID is discarded and the Vortex Ring Parachute (VRP) is deployed to provide a stable environment to search for targets. The spin and drop rates are such that the sensor scans a large area in ever decreasing circles for the targets. Once a target has been detected, the multimode sensor (MMW and IR) and processor will validate the target and preset the fire requirement. When a fire decision is made the lethal mechanism, which is an Explosively Formed Penetrator (EFP) warhead, is fired at the target. The explosive in the EFP warhead forms the metal plate into an aeroballistically stable slug which travels at a high velocity and penetrates the vulnerable upper surfaces of armoured vehicles.

In July 1989, Aerojet Electronic Systems successfully completed the early system demonstration phase of their entry in the SADARM.

The live tests demonstrated successful submunition ejection from an artillery projectile, deceleration/despin, target detection, aiming, warhead firing and perforation of an armoured target by the Explosively Formed Penetrator (EFP) mechanism.

Status: Full-scale development under contract to US Army. Low rate initial production for 155 mm in FY94.

Contractors: Aerojet Electronic Systems Division, 1100 West Hollyvale Street, PO Box 296, Azusa, California 91702-0296, USA. Telephone: (818) 812 2165 Fax: (818) 969 4613

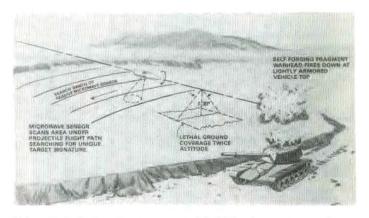
Alliant Techsystems 120 mm Smart Target Activated Fire-and-Forget (STAFF) 120 mm Tank Round XM943

In late 1992, Alliant Techsystems released some information on the 120 mm STAFF round that it was developing in co-operation with Tank Main Armament Systems (TMAS) and Armament Research Development and Engineering Centre.

STAFF is a 120 mm tank round that searches out and destroys enemy armour beyond the reach of conventional munitions. Although STAFF is primarily designed as an anti-armour round it complements the M830A1 HEAT-MP-T tank round by being highly lethal against helicopters.

According to Alliant Techsystems, the large sensor footprint of the XM943 and stand-off capability of its explosively formed penetrator warhead, create a lethal basket some 75 to 100 times larger than the target area for kinetic energy of HEAT rounds. Because of this large lethal basket, STAFF is claimed to be exceptionally tolerant of aiming, dispersion and system errors. For the tank crew, the result is a greater probability of kill against targets, especially those seen only fleetingly because of evasive action or terrain masking.

All of the critical subsystems have been successfully demonstrated with a proof-of-principle demonstration being carried out in 1990. STAFF development is said to be on plan.



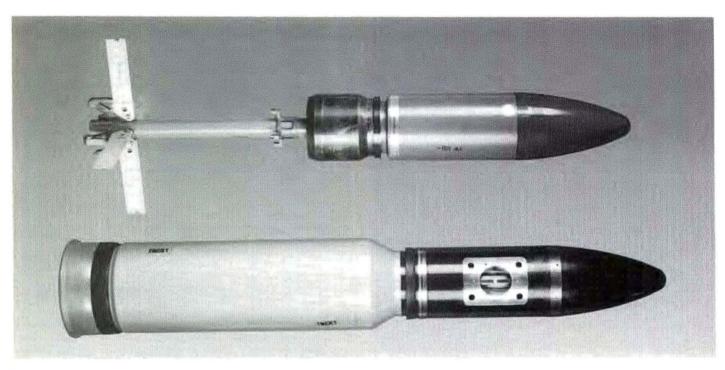
Schematic indication of main concept of STAFF anti-armour projectile

STAFF requires no change to the tank turret and no unique actions by the tank crew other than setting a single range zone switch. From aiming to firing to the last stages of its operation, STAFF functions much like a conventional round. During its ballistic flight, STAFF establishes a vertical reference and orients itself with the ground. In the final seconds of flight, a search and track mode is initiated. The forward scanning millimeter-wave sensor establishes a large footprint for target acquisition. The round flies over the target, rolls to align the warhead, fuzes and fires its lethal penetrator down into the tank.

Status: Development.

Manufacturer: Alliant Techsystems, 600 Second Street NE, Hopkins, Minnesota 55343, USA.

Telephone: (612) 931 5164

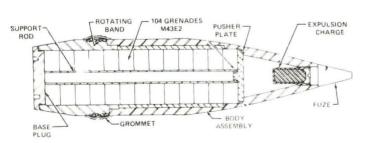


STAFF projectile in flight with fins extended (top) and complete XM943 STAFF round below

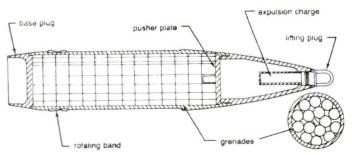
203 mm (8 in) Ammunition for M115 Towed Howitzer and M55 and M110 Series of Self-propelled Howitzers

Calibre	Type	Application	Designation	Weight (projectile)	Type/weight of filling	Length (projectile)	Notes
203 mm	Agent GB or VX	1-4	M426	92.53 kg	6.57 kg/GB or VX	892 mm	fuze PD M557, Prox, M728. GB is non-persistent, VX is persistent
203 mm	Dummy	1-4	M14	90.72 kg	n/a	874 mm	fuze n/a
203 mm	HE	1-4	M106	92.53 kg	16.46 kg/TNT 17.59 kg/Comp B	871 mm	fuze PD M78, M557, MTSQ M564, M582
203 mm	HE/ICM	1-4	M404	90.72 kg	104 M43A1 anti- personnel grenades	886 mm	fuze MT M565, MTSQ M557
203 mm	HE/ICM	3-4	M509/M509A1	93.66 kg	180 M42 dual- purpose grenades	1115 mm	fuze MTSQ M577
203 mm	HERA	4	M650	90.78 kg	11.35 kg/TNT	1116 mm	fuze PD M739, M557, M572, VT M732, M564 and M582 MTSQ
203 mm	Nuclear	1-4	M422	120 kg	n/a	940 mm	tactical nuclear Uranium 235 in highly enriched oralloy form as fissile material 12 kt and 1.2 kt. Warhead is the W33, training round is M423, spotting round M424.
203 mm	Nuclear	4	M753	97.73 kg	n/a	1092 mm	tactical nuclear, will replace M422. Warhead Plutonium 239 is fissile material. Three yields up to 2 kt. Warhead is W79, operational since 1981.

- 1 M115 towed howitzer (no longer used by US Army)
- 2 M55 self-propelled howitzer (no longer used by US Army)
- 3 M110 self-propelled howitzer (no longer used by US Army)
- 4 M110A1/A2 self-propelled howitzer (no longer used by US Army)



Cutaway drawing of 203 mm (8 in) projectile HE M404 (US Army)



Cutaway drawing of 203 mm (8 in) projectile M509 (US Army)

175 mm Ammunition for M107 Self-Propelled Gun

SPECIFICATIONS

Designation	M458	M437A1	M437A2	Designation	M458	M437A1	M437A2
CALIBRE	175 mm	175 mm	175 mm	LENGTH (projectile)	866 mm	867 mm	867 mm
TYPE	Dummy	HE	HE	FUZE	no fuze	fuze PD M572,	fuze PD M572
WEIGHT (projectile)	67.45 kg	66.78 kg	66.87 kg			Prox M514, M728,	Prox M514, M728,
TYPE/WEIGHT						MTSQ M582	MTSQ M582
(filling)	inert	13.6 kg/TNT	14.06 kg/Comp B				

Note: The 175 mm M107 is no longer in service with the United States Army but is still used by some other nations.

AAI Ammunition

Although the AAI Corporation is well known for its experience in the design and development of light tracked vehicles, tracks and turret systems, it has also been involved in the design and development of ammunition for both the home and export markets.

40 mm APFSDS Round Model 68462

This round has been developed as a private venture by AAI from 1981 and has been designed for firing from 40 mm L/60 guns, although its design could also be adapted for the Bofors 40 mm L/70 gun. It can be used to engage moderate armoured targets to a maximum range of 4000 m.

AAI's programme objectives for developing this round were a high terminal velocity and penetration power, tracer or impact spotting capability, high precision, compatibility with L/60 or L/70 gun, low muzzle flash and blast and environmental endurance.

The round utilises a unique gapless sabot design to pull a tungsten penetrator through the gun barrel. Muzzle flash and blast pressure are minimised by a special formulated mixture of standard propellants.

Optional spotting ability is provided by an incendiary-filled windscreen that produces a brilliant flash upon impact with soft or hard targets at long stand-off distances. The trace option is provided by a tracer mix assembled into the base of the projectile fin.

The high muzzle velocity is sustained through low aerodynamic projectile drag, assisted by a streamlined aluminium windscreen. These attributes combine to provide substantially decreased projectile flight time compared to standard L/60 and L/70 ammunition.

Penetration at high angles of impact is aided by the blunt nose construction of the tungsten penetrator which reduces penetrator break up at oblique impacts with targets. High projectile drag is avoided by the streamlined windscreen which also serves to contain the optional stotter charge.

SPECIFICATIONS

CALIBRE	40 mm
CARTRIDGE CASE	40 mm Mk 3 (steel or brass)
WEIGHT COMPLETE	1.62 kg
LENGTH OVERALL	445 mm
PENETRATOR WEIGHT	230 g
AVERAGE CHAMBER PRESSURE	279.20 MPa
AMBIENT PEAK PRESSURE	269 MPa
AMBIENT MUZZLE VELOCITY	1335 m/s
NOMINAL PRECISION	0.5 mil
PRIMER	Mk 22 percussion
STATIC DEBULLET FORCE	approx 8000 N

75 mm Ammunition for ARES Gun

For this weapon the company developed two telescopic rounds, the APFSDS-T XM885 and the HE XM884, both of which used an M63 electric primer. So far the 75 mm ARES gun has yet to enter production.

76 mm M464 APFSDS-T Round

This round was developed as a private venture by AAI to increase the effectiveness of the M41 light tank to defeat armour at extended ranges. Due to the low aerodynamic drag exhibited by the fin-stabilised tungsten penetrator, high terminal velocities are sustained thereby providing penetration capability.

The round is US safety certified and is safe to stow, transport and handle

between -46 and $+63^{\circ}$ C and safe to fire between -46 and $+52^{\circ}$ C in the M32 gun installed in the M41 light tank.

AAI has sold a quantity of these rounds to Denmark for use with their M41 light tanks which were upgraded in the 1980s.

7.65 kg

SPECIFICATIONS

WEIGHT	7.03 kg
PROJECTILE WEIGHT	2.49 kg
PENETRATOR DIAMETER	20.6 mm
LENGTH TO DIAMETER	
RATIO OF PENETRATOR	15/1
PENETRATOR MATERIAL	tungsten alloy
ABLATOR ASSEMBLY	0.06 kg
CHAMBER PRESSURE	3489 bar
MUZZLE VELOCITY	1400 m/s
PRECISION	0.5 mil max
ARMOUR PENETRATION	
AT 1000 m	NATO heavy single target at 53° obliquity
	NATO heavy triple target at 57° obliquity

105 mm High Explosive Air Defence (HEAD) Ammunition

The company has developed, as a private venture, the 105 mm HEAD round which can be fired from standard 105 mm rifled tank guns as fitted to the M60 series of MBTs and the M1 Abrams MBT.

The 105 mm HEAD round has a lower impulse than the current M456 HEAT round and according to AAI would be highly effective against buildings, bunkers, light armoured vehicles and troops.

It consists essentially of a standard HE M1 artillery projectile fitted with a new nose-mounted Mk 404 passive infra-red fuze and mated to a standard M150B1 cartridge case filled with M30 propellant and fitted with an M80A1 primer.

All key components of the HEAD round are standard non-developmental items and the round could be ready for production within a year of a firm go ahead.

Prototype HEAD rounds have already been demonstrated in unmanned firings in the United States and in 1987 were demonstrated to representatives of 13 NATO armies in Germany.

AAI is also exploring the possibility of introducing a 120 mm version of the HEAD round for use by the M1A1 MBT.

SPECIFICATIONS

or con to Attorio	
CALIBRE	105 mm
TOTAL WEIGHT	25.4 kg
WEIGHT OF PROJECTILE	15 kg
HE WEIGHT	2.31 kg
PROPELLANT TYPE	M30
AMBIENT PEAK CHAMBER PRESSURE	241.3 MP
MUZZLE VELOCITY	774.2 m/s
TIME OF FLIGHT	
to 1 km	1.37 s
to 2 km	2.90 s
to 3 km	4.62 s
to 4 km	6.55 s
to 5 km	8.71 s

Manufacturer: AAI Corporation, PO Box 126, Hunt Valley, Maryland 21030-0126, USA.

Telephone: (301) 666 1400 Telex: 8-7849 Fax: (710) 232 1800

Martin Marietta Copperhead 155 mm Cannon-Launched Guided Projectile (CLGP)

Development

The 155 mm Cannon-Launched Guided Projectile (CLGP) was originally conceived by the engineering staff of the United States Army's Rodman Laboratories in 1970. The following year feasibility studies were conducted by the Army Missile Command, Picatinny Arsenal, Rodman Laboratories and the United States Navy Naval Weapons Laboratory at Dahlgren.

Japan and South Korea have evaluated Copperhead but the only country to receive it is Jordan which is understood to have taken delivery of 100 rounds from the USA in 1987.

The Copperhead was used by the US armed forces during Operation Desert Storm in early 1991. Full details of the development were given in Jane's Armoured Fighting Vehicle Retrofit Systems 1992-93 pages 134/135.

Description

The Copperhead consists of three separate sections, guidance (seeker and electronics assemblies), warhead and stabilisation and control,

The guidance section houses the seeker and electronics assemblies. The seeker head includes a window, spider-mounted cover plate, direct impact sensor and four quadrant detectors, preamplifier and optical filter assembly, followed by the gyro, torque coils and spring gyro spin-up device. A gotcha device unloads the gyro ball bearings during firing acceleration to prevent brinelling. The gyro is spun up mechanically and maintained electrically. Body-fixed optics are used and the spin-stabilised gyro mirror directs the laser signal into the detector, which senses guidance errors for the proportional navigation guidance scheme.

The electronics assembly contains interconnected, annular printed circuit boards with section interfaces connected by a rigid flex motherboard supported by aluminium rings which transfer the shock load into the housing. The assembly is compressed and bolted to prevent break up at firing. Holes in the centre of the electronics assembly permit the HEAT warhead to pass through without interference.

The warhead section consists of the Composition B shaped charge with a copper liner, a free space cone to permit jet formation, a safe and arm and dual channel fuze module (providing safety and in-flight arming of the firing train) and six grazing sensors to detonate the warhead if the nose sensor does not impact the target. A ribbon cable through the warhead section carries command signals from the guidance section to the control section and fuzing signals to the warhead initiator.

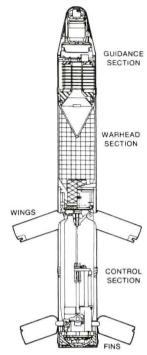
The stabilisation and control section contains deployable wings, the wing release and extension mechanism (squib-actuated), the control system (including a two-element thermal battery, helium bottle, cold gas actuator, actuation electronics, deployable control fins and housing), slip obturator and aft closure. The slip obturator provides a gas seal and decouples the projectile from the bore preventing the full spin-up encountered by conventional projectiles. The aft closure serves as the pusher plate and provides for extractor engagement.

The Copperhead can be fired from the following weapons: M109A1 and M109A2 self-propelled howitzers, M198 and M114 towed howitzers, International FH-70, the French 155 mm GCT self-propelled gun and the Japanese Type 75 self-propelled howitzer.

Targets for Copperhead can be designated by a number of ground and airborne lasers including the Hughes Ground Laser Locator Designator (GLLD), Hughes Laser Target Designator (LTD), Hughes Modular Universal Laser Equipment (MULE), RPVs, Target Acquisition and Designation System (TADS) mounted in the McDonnell Douglas Helicopters AH-64 Advanced Attack Helicopter and a laser designator mounted in a modified version of the Emerson Improved TOW Vehicle. It has also been successfully demonstrated in conjunction with the Ferranti Laser Target Marker and Ranger. At present the Copperhead is principally a day system although the GLLD fitted with a TOW night sight has been successfully tested.

In a typical engagement a forward observer detects the enemy armoured advance and calls for Copperhead indirect fire from an artillery unit. The forward observer relays the approximate position of the target to the gun and the CLGP is then fired. After the CLGP is launched the fins deploy to stabilise the round and at a preset time the wings are deployed and the quidance electronics are activated. The CLGP is sufficiently manoeuvrable to cover a large area and can seek out and destroy targets during marginal weather and low cloud ceilings. During the flight of the projectile the forward observer designates the target with his laser beam and the Copperhead's electro-optical seeker locks on to the target. During trials Copperhead successfully hit stationary and moving targets at ranges of 4, 8, 12 and 16 km, some head on and some side on. In one test two tanks in near





Copperhead CLGP, left, with wings and fins extended; right, showing main

proximity were destroyed by two CLGPs fired from different M109A1s with each CLGP being guided to the target by a different forward observer using a laser designator (with one code apart).

Martin Marietta has demonstrated a new design incorporating microprocessor circuitry, a more simple gyroscope and the capability to reprogram internal software in the field to meet a changing threat.

The improved guidance section uses one third fewer parts leaving room for the precursor section of a tandem warhead. It is possible that the new seeker together with a new warhead, could be retrofitted in the US Army's existing stock of over 20 000 Copperhead CLGPs.

Martin Marietta is under a \$30.5 million, four year contract to develop a seeker that combines imaging infra-red technology with the existing semiactive laser guidance. Captive flight testing of the seeker started in 1989.

As a private venture, Martin Marietta is developing a shorter version of Copperhead which is 990 mm long compared to the standard projectile which is 1300 mm in length. The key innovation is that the fins near the midpoint fold around the circumference of the projectile saving internal space, no longer needed for the folded fins, thus allowing for a shorter airframe.

Recent US Army tests of Copperhead with a slightly modified warhead have proven its effectiveness against explosive reactive armour. A slight delay in the fuze allows the kinetic energy of the projectile itself to penetrate the explosive reactive armour before the shaped charge is detonated. Further improvements to the warhead are expected to improve Copperhead's penetration by up to 25 per cent.

In addition, the US Army is considering a fire-and-forget version of the Copperhead. Martin Marietta is developing a dual mode seeker combining imaging infra-red with the existing semi-active laser capability for possible use on the fire-and-forget Copperhead and other missile programmes

SPECIFICATIONS

CALIBRE	155 mm
WEIGHT	
complete projectile	63.5 kg
warhead	22.5 kg
Comp B in warhead	6.4 kg
LENGTH (projectile)	1.372 m
MAX RANGE	16 000 m

Status: Production was completed in 1990.

Manufacturer: Martin Marietta Orlando Aerospace, PO Box 5837, Orlando,

Florida 32805, USA

Telephone: (305) 356 2000 Telex: 564 414

Hercules 155 mm Unicharge

The Hercules 155 mm Unicharge is a 152 mm long rigid combustible cartridge case that will contain granular propellant. One propellant candidate is the new IM formulation (HES 9268) which has demonstrated reaction levels 80 per cent less than M301A stick propellant during tests at ARDEC using shape charge warheads.

Unicharge is a single common increment and is used in multiples of two

to six increments to provide the range now covered by the M3A1, M4A2, M119A2, M203A1 and XM224, all of which it will replace. The 39 calibre cannon will use up to five increments while the 52 calibre cannon will use up to six increments.

Unicharge is an additive system that effectively uses every increment and eliminates the need to dispose of unused increments. In addition this

also reduces the amount of propellant required in the system to accomplish the required missions

Unicharge will support higher rates of fire through automation, but can also be loaded manually, allowing its use with existing 155 mm howitzers.

According to Hercules, the Unicharge offers the following advantages: (1) designed to meet the AFAS requirements (only at 40 km, max range

- assisted)
- (2) propellant full-scale development low risk
- (3) HES 9268 meets IM requirements
- (4) backward compatible with existing howitzers
- (5) allows NATO interoperability

(6) logistics system exists

(7) minimal training requirement

(8) compatible with existing production base.

Note: Hercules is also involved in other ammunition developments including the 120 mm X-ROD programme (qv).

Status: Development.

Manufacturer: Hercules Aerospace, Wilmington, Delaware 19894, USA.

Telephone: (302) 594 6379

Martin Marietta Ammunition

Martin Marietta Ordnance Systems operates the US Army's ammunition plant at Milan, Tennessee. This large and automated facility produces a wide range of ammunition types including 60 mm, 81 mm and 120 mm mortar bombs, 40 mm grenades, fuzes, rocket warheads and components. demolition kits and accessories. Artillery and tank gun ammunition produced as required includes the following:

105 mm M490 TP-T

105 mm M724 and M724A1 TPDS-T

- 105 mm M456, M456A1, M456A2 HEAT-T-MP
- 105 mm M735 APFSDS-T
- 105 mm M833 APFSDS
- 155 mm ICM M483A1
- 155 mm ICM M864
- 203 mm ICM M509A1.

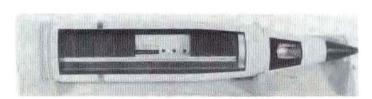
Manufacturer: Martin Marietta Corporation, Milan Army Ammunition Plant, Milan, Tennessee 38358, USA

Thiokol Ammunition

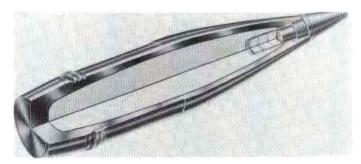
As part of its overall aerospace-related industries Thiokol Corporation operates two Government-Owned Contractor-Operated (GOCO) ordnance plants for the US Army. GOCO plants are operated as separate military installations administered by a resident US Army staff under the US Army Armament Munitions Chemical Command (AMCCOM) at Rock Island, Illinois. US Army policy now supports and encourages use of GOCOs for the development and production of all US Government armament requirements so Thiokol Corporation can contract directly with other US Government agencies and/or prime system contractors using existing GOCO facilities on a rent-free basis. Direct sales to foreign customers are also authorised when rental rates and other factors can be negotiated with the US Army. Thiokol has two GOCO plants in Louisiana and Texas and Thiokol's Utah Tactical Division manufactures illuminating ammunition such as the M257 flare

Listed below is the artillery ammunition produced by Thiokol.

Smoke WP M825 This projectile can produce a smoke screening cloud for up to 10 minutes by using wedge-shaped pieces of felt saturated with White Phosphorus (WP). The projectile uses an M483A1 ogive and expulsion charge and a modified M483A1 body with a threaded steel ring/aluminium body base. A hermetically sealed canister inserted into the body contains 116 WP saturated felt wedges separated into four quadrants of 29 wedges. A burster charge causes the canister to eject from the projectile body and then scatters the wedges over the target area to produce a dense smoke cloud in less than 45 seconds. The M825 weighs 46.72 kg.



Projectile, 155 mm, Smoke, WP, M825



Projectile, 155 mm, HE, M107, Comp B

HE M107 This is one of the US Army's standard HE projectiles and is also a NATO standard munition. It contains 6.985 kg of Composition B and the projectile weighs 43.1 kg.

HE M692/M731 These Area Denial Artillery Munitions (ADAMs) each deliver 36 anti-personnel mines. After scattering, the mines deploy trip lines which cause the mine to be actuated on contact. An electronic firing circuit causes the mine to be projected upwards where it detonates to scatter fragments in all directions. Each projectile is 899 mm long, fuzed and weighs 46.49 kg

Illuminating M485A2 This projectile uses an M577 fuze and produces one million candlepower for 110 seconds. It is 604.5 mm long and weighs

Illuminating NR109 The NR109 utilises the M485A2 hardware combined with a modified flare candle to provide an initial illumination of 3 million candlepower decreasing to 1.5 million as the carrier parachute descends, resulting in almost constant ground illumination over a 70 second burning time. It is otherwise identical to the M485A2.

M864 DP/ICM Base Bleed This 155 mm artillery shell is an extended range companion to the currently fielded M483A1. It carries a cargo of high explosive grenades.

105 mm

Illuminating Cartridge M314A3 This uses a parachute-suspended illuminant to produce 400 000 candlepower for at least 55 seconds. It uses an M565 (MT) or M577 (MTSQ) fuze and weighs 21.06 kg. Maximum range is 8700 m

In addition to the above Thiokol Corporation also produces land mines, various pyrotechnics and simulators, mortar ammunition, rocket warheads and solid propellants.

Manufacturer: Thiokol Corporation, 2475 Washington Blvd, Ogden, Utah 84401, USA.

Telephone: (801) 629 2270



155 mm Illuminating Projectile, M485A2



105 mm Illuminating Cartridge, M314A3

Olin Ordnance Ammunition

Olin Ordnance manufactures small, medium and large calibre ammunition, provides systems management for weapons platform projects and operates several Government-Owned Contractor Operated (GOCO) facilities in the United States. Component products include BALL POWDER propellant and combustible fibre products. Olin Ordnance took over the General Defense Corporation in 1988 and their ammunition is now included in the Olin Ordnance range of products.

Olin has also been successful in co-production and technology transfer, having set up facilities in Turkey for Olin 105 mm APFSDS tank ammunition. Olin provided the technology, machinery and equipment for a manufacturing facility and test range. Olin's product range covers small, medium and large calibre ammunition types.

Medium Calibre Ammunition

Olin is the sole producer of the improved 20 mm PGU family of ammunition used by the US Navy and US Air Force fighter aircraft armed with 20 mm M61 and M197 gun systems.

The company is also the leading US developer of the PIE (Pyrotechnically Initiated Explosive) technology which is adaptable to all calibres in the 12.7 to 40 mm range.

Olin also manufactures the medium calibre ammunition for a number of other major US systems including Mk 149 Mod 2 and 4 cartridges for the US Navy's Phalanx Close-In Weapon system, M940 MPT-SD (replacement for the M246 HEIT-SD cartridge) for the US Army Vulcan air defence systems and the M788 and M789 30 mm cartridges for the M230 Chain Gun installed in the AH-64 attack helicopter. Details of US Army ammunition types are given under their respective full listing later in this section. Details of private venture ammunition are given later in this entry.

Olin Medium Calibre Ammunition

20 mm M53 API

20 mm M55 TP

20 mm M56 HEI

20 mm Mk 149 (Mod 2 and 4) (CIWS)

20 mm M220 TP-T

20 mm M242 HEIT

20 mm M246 HEIT-SD

20 mm M940 MPT-SD

30 mm PGU-30/B TP-T

20 mm PGU-28B SAPHEI

20 mm PGU-27 TP

25 mm PGU-32/U SAPHEI

25 mm PGU-33/U TP-F

30 mm M788 TP

30 mm M789 HEDP

Large Calibre Ammunition

Olin is a major supplier to the US Army of both 105 mm and 120 mm tank ammunition. In addition Olin's FP105 APFSDS round has been NATO type classified in Canada and can be fired from the British L7, US M68 and French F1 tank guns. The round is currently used by a number of countries. In late 1991 Olin introduced an advanced technology APFSDS round capable of performance previously only associated with 120 mm gun systems, according to Olin.

In response to requirements from overseas customers for a non-DU projectile, Olin has also developed as a private venture two new 120 mm APFSDS rounds utilising tungsten penetrators. These new rounds are known as the Olin 120 and Olin 120 plus. These new rounds are ballistically matched to the current US Army tactical rounds and both can be fired from the M1A1 Abrams without modifications.

Olin also manufactures artillery ammunition for 155 mm and 203 mm (8 in) weapons. This includes both the M483A1 and the M864 Base Bleed Improved Conventional Munition and the BGD155C, a private venture cargo round designed specifically for export.

Olin Ordnance has been involved in the research and development of ET-C (ElectroThermal – Chemical) ammunition systems. These research efforts have been directed at basic technologies applicable to the development of ET-C gun and ammunition systems which will be capable of achieving significant performance improvements over conventional or liquid propellant systems. Olin anticipate performance gains in the order of 50 per cent. These gains will be with propellant systems which will be considerably safer and exhibit much lower vulnerability characterstics than have been typical of traditional high energy chemical based systems.

Olin Ordnance has been conducting a variety of independent, company funded development efforts on the 140 mm ATAC ammunition. Areas of development include several unique propellant/ignition systems, various high performance projectile designs and system level performance analysis.

The majority of the 140 mm ammunition development has been conducted by the US Army ARDEC located at Picatinny Arsenal. Olin has already successfully demonstrated the viability of several of its own concepts when fired from the 140 mm weapons.

Olin Tank Ammunition

105 mm M456A2 HEAT-T

105 mm M490 TP-T

105 mm M724A1 TPDS

105 mm M737 TPDS

105 mm M833 APFSDS

105 mm FP105 APFSDS

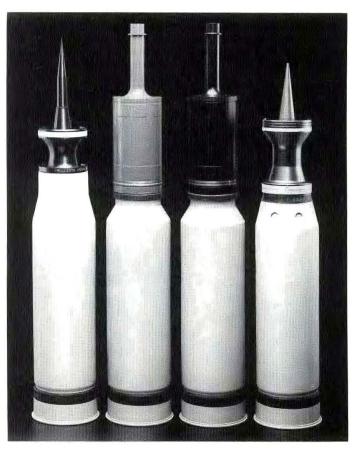
105 mm Olin 105 APFSDS 120 mm M829/M829A1 APFSDS-T

120 mm M830A1 HEAT

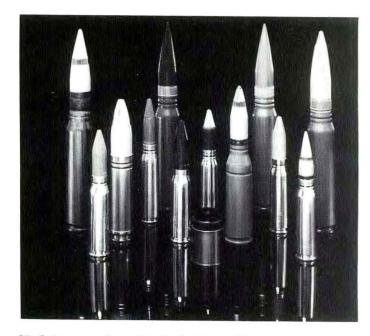
120 mm M831 TP-T



Combustible fibre products specifically for 120 mm tank ammunition



120 mm tank rounds for M1A1 Abrams MBT with HEAT-MP-T in centre and APFSDS-T either side



Olin Ordnance medium calibre family of ammunition



8 in/203 mm HERA M650 projectile



8 in/203 mm HE/ICM M509A1 projectile

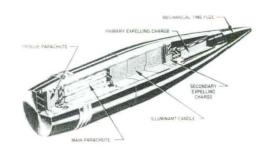
120 mm M865 TPCSDS-T 120 mm Olin 120 APFSDS 120 mm Olin 120 + APFSDS

Olin Artillery Ammunition

155 mm M107 HE 155 mm M483A1 ICM 155 mm M485A2 Illuminating 155 mm M549A1 RAP 155 mm M864 BB ICM 155 mm BGD155C ICM 203 mm M106 HE 203 mm M509A1 ICM

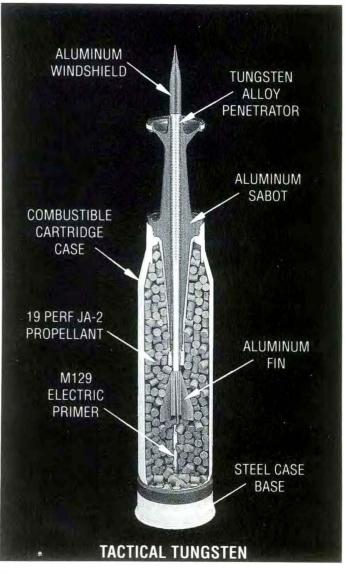
203 mm M650 HERA

Olin Defense Systems Group also operates three Army Ammunition GOCOs: Lake City Army Ammunition, Independence, Missouri (5.56 mm, 12.7 mm and 20 mm); Ravenna Army Ammunition, Ravenna, Ohio, for standboy equipment and demilitarisation; and the Badger Army Ammunition, Baraboo, and BALL BOWLDER. Wisconsin, for standby artillery, rocket propellants and BALL POWDER propellants.

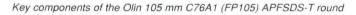


155 mm Illuminating M485A2 projectile

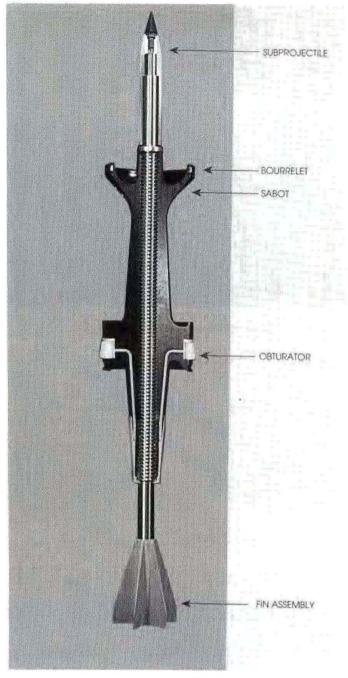
SPECIFICATIONS		
Designation	C76A1 (FP105)	C127
Type	APFSDS-T	APFSDS-T
CALIBRE	105 mm	105 mm
APPLICATION	L7/M68	L7/M68
LENGTH (complete)	927 mm	1010 mm
LENGTH (projectile)	475 mm	584 mm
WEIGHT (projectile)	5.8 kg	3.18 kg
WEIGHT (sub-projectile)	3.6 kg	3.44 kg
DIAMETER		
sub-projectile	26 mm	n/avail
WEIGHT (propellant)	6.2 kg	6 kg
TYPE (propellant)	M30 triple base	BALL POWER
PENETRATOR MATERIAL	tungsten alloy	tungsten alloy
SABOT	aluminium	aluminium
FIN MATERIAL	aluminium	aluminium
WINDSHIELD MATERIAL	aluminium	aluminium
TIP MATERIAL	steel	steel
BOURRELET/MATERIAL	stainless steel	stainless steel
OBTURATOR/MATERIAL	nylon	nylon
SEAL BAND/MATERIAL	polypropylene	polypropylene
MUZZLE VELOCITY	1508 m/s	1560 m/s



Main components of the Olin 120 KE-W terminator round



Designation	120 Olin + (or KE - W Terminator
Type	APFSDS-T
CALIBRE	120 mm
APPLICATION	M256
LENGTH (cartridge)	980 mm
LENGTH (projectile)	778 mm
WEIGHT (cartridge)	20.5 kg
WEIGHT (projectile)	8.2 kg
TYPE (propellant)	JA-2 19 perf
WEIGHT (propellant)	7.9 kg
MUZZLE VELOCITY	1590 m/s



Key components of the Olin 105 mm C127 APFSDS-T round

Manufacturer and sales headquarters: Olin Ordnance, 10101 9th Street North, St Petersburg, Florida 33716, USA.

Telephone: (813) 578 8100 Fax: (813) 578 8128

Washington Office: Olin Ordnance, 1730 K Street NW, Suite 1300,

Washington DC 20006, USA.

Telephone: (202) 331 7400 Fax: (202) 331 0733

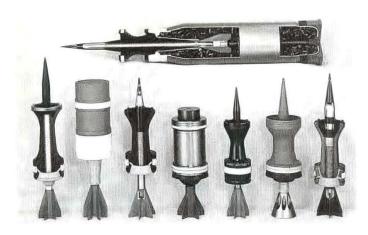
Chamberlain Manufacturing Corporation Ammunition

Chamberlain is one of the world's largest manufacturers of ammunition metal parts, weapons, advanced warheads and military obscurant systems. The company operates ordnance manufacturing plants in Waterloo, lowa and Scranton, Pennsylvania and specialises in the design and production of items from 60 to 203 mm.

Chamberlain's MRC Division, located in Maryland, specialises in automated inspection and handling equipment and obscurant systems.

Saco, Maine, is a leading manufacturer of small and medium calibre arms for the US armed forces and international customers and exclusive supplier of the M60, M2 HB and Mk 19 series machine guns to the US armed forces.

Chamberlain serves as prime contractor for transferring technology and supplying metal parts or complete rounds of ammunition throughout the world. Types of ammunition developed and/or recently produced for the US Army and for domestic and foreign customers include:



Chamberlain produced ammunition, top, 120 mm M829, bottom, left to right, 105 mm M833, 120 mm M829 ballistic slug, 105 mm M774, 120 mm ballistic slug, 90 mm CN 90, 120 mm M865 and 105 mm M735

Waterloo, Iowa facility 90 mm, CN 90, APFSDS-T projectile

90 mm, M432 HEAT projectile

105 mm, M833 APFSDS-T projectile 105 mm, CMC 105, APFSDS-T projectile

105 mm, M900 APFSDS-T, latest 105 mm to enter production

105 mm, M900E1 APFSDS-T projectile

105 mm, M735 and M774 ballistic standards

105 mm, M829 and XM900 ballistic slugs

105 mm, XM915 ICM projectile, MPTS development 105 mm, XM916 ICM projectile, MPTS development

4.2 in, M329A1 HE projectile

4.2 in, M335A2 Illuminating projectile 120 mm, M865 TP-T projectile

120 mm, M865 TP projectile

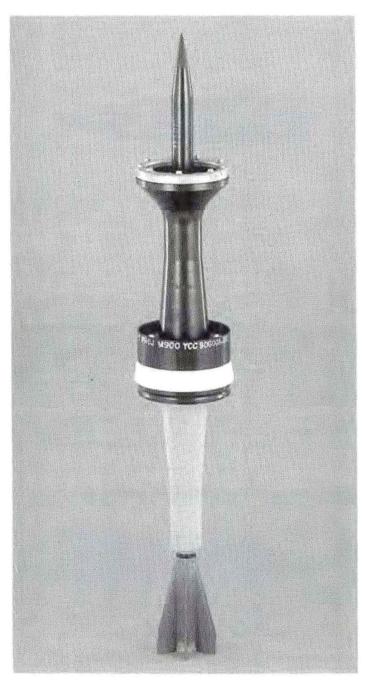
120 mm, M829 APFSDS projectile 120 mm, M829E1/E2, MPTS and engineering support

152 mm, XM579 APFSDS projectile

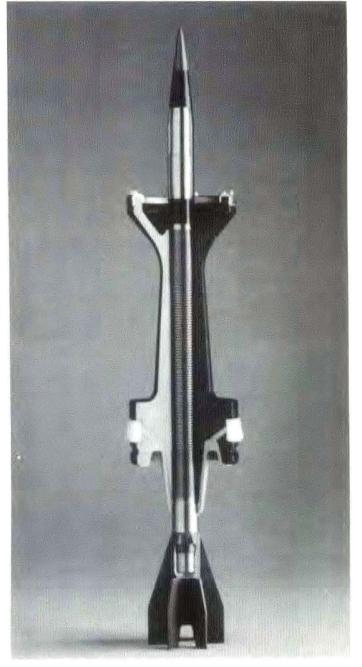
152 mm, M411 TP projectile

155 mm, XM785, Nuclear, development

155 mm, XM898 MPTS and engineering support



Chamberlain 105 mm M900 APFSDS-T projectile with a muzzle velocity of



Chamberlain Manufacturing Corporation 105 mm APFSDS-T projectile CMC 105

The latest private venture 105 mm APFSDS-T to be developed by the Chamberlain Manufacturing Corporation is the CMC 105 and specifications of this are as follows:

 CALIBRE
 105 mm

 WEIGHT (complete round)
 17.15 kg

 LENGTH (complete round)
 998.73 mm

 CARTRIDGE CASE
 M148A1B1

 PRIMER
 M120

 TRACER
 M13

 WEIGHT
 5.014

projectile 5.8 kg sub-projectile 3.56 kg (in-flight)

PENETRATOR

material Monobloc Tungsten Alloy

 weight
 3.31 kg

 diameter
 22.23 mm

 length
 444.5 mm

 LENGTH TO DIAMETER RATIO
 20:1

 PROPELLANT
 M30

 PROPELLANT WEIGHT
 6.1 kg

 SERVICE CHAMBER PRESSURE
 4150 bar

 MUZZLE VELOCITY
 1501 m/s

 VELOCITY LOSS
 55 m/s km

 PERFORMANCE

 NATO Heavy Triple
 5700 m

NATO Heavy Single 4000 m
High obliquity 178 mm at 67° (equivalent 455 mm)

at range of about 2600 m
Scranton Army Ammunition Plant

5 in 54 cal Mk 61-1 projectile 155 mm, M483A1 ICM projectile 155 mm, M485A2 projectile 155 mm, M107 HE projectile 155 mm, M110 Chem/WP projectile 155 mm, M804 Training projectile 155 mm, M864 ICM projectile 8 in, M509 ICM projectile 120 mm, XM935 mortar

Manufactured and marketed by: Chamberlain Manufacturing Corporation, 845 Larch Avenue, Elmhurst, Illinois 60126, USA.

Telephone: (708) 279 3600 Telex: 721476 Fax: (708) 530 6057

Talley Defense Systems Extended Range Ammunition

155 mm M864 Dual Purpose Improved Conventional Munition

Talley Defense Systems is the US Army producer of the 155 mm Base Burner Assembly (also known as base bleed) for the M864 155 mm Dual Purpose Improved Conventional Munition (DPICM) extended range artillery projectile.

M864 Base Burner Assemblies were developed and produced at the production facility in Mesa, Arizona. Under agreement with the US Army, Talley Defense Systems has established an M864 Base Burner Assembly production facility at Joliet Army Ammunition Plant currently delivering 15 000 subassemblies per month.



M864/M483A1 projectile comparison

M114A2

CRECIFICATIONS

FH-70

Type	M864	M483A1
MAX RANGE	28 100 m	17 400 m
WEIGHT	46.8 kg	47 kg
LENGTH	897.6 mm	897.8 mm
PAYLOAD	72	88
	submunitions	submunitions
	$(24 \times M46)$	$(24 \times M46)$
	(48 × M42)	(64 × M42)
MATERIALS		Lanconcommunit
ogive	steel	aluminium
body	steel	steel/fibreglass
base	steel	aluminium
Max range for M864 projectile		
WEAPON	charge	range
M198	M203A1	28 100 m
M109A2	M119A2	22 000 m

M4A2 (zone 7)

L10

Cross-section of 155 mm M864 DPICM Base Burner Projectile

Other products

Talley Defense Systems is the developer and single production source for the rocket motor grain on the US Army M913 High Explosive Rocket-Assisted Projectile. The M913 was developed for the US Army adaption of the UK developed 105 mm L119 Lightweight Howitzer. Designated as the M119, this howitzer and projectile combination achieve extended ranges in excess of 19 km. A variation of the M913, designated the XM927, utilises an alternative propelling charge to allow firing in the older M101 and M102 105 mm Howitzers. The XM927 increases the range of these older howtizers to 16.5 km.

Manufacturer: Talley Defense Systems Inc, 3500 North Greenfield Road, PO Box 849, Mesa, Arizona 85211, USA.

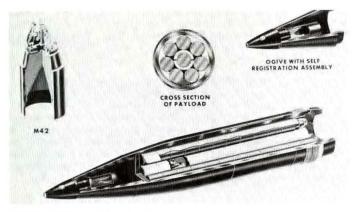
Telephone: (602) 898 2200 Telex: 66-7408 Fax: (602) 898 2358

155 mm Ammunition for M114 and M198 Towed Howitzers and M44 and M109 series of Self-propelled Howitzers

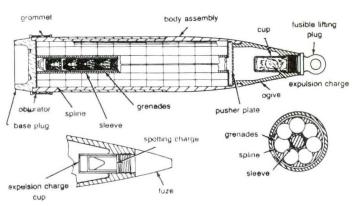
17 100 m

28 100 m

SPECIFIC	ATIONS						
Calibre	Type	Application	Designation	Weight (projectile)	Weight/type of filling	Length (projectile)	Notes
155 mm	Agent H/HD	1-5	M110	42.91 kg	5.3 kg/H or 4.39 kg/HD	607 mm	fuze PD M557, MTSQ M520, M564
155 mm	Anti-tank	3-5	M718	46.7 kg	9 anti-tank mines*	781 mm	fuze MTSQ M577
155 mm	Anti-tank	3-5	M741	46.7 kg	9 anti-tank mines†	781 mm	fuze MTSQ M577
155 mm	Dummy	1-5	M7	42.91 kg	n/a	700 mm	no fuze
155 mm	HE	1-5	M107	42.91 kg	6.62 kg/TNT or 6.98 kg/Comp B	607 mm	fuze PD M557, M78, MTSQ M564, Prox M514, M728
155 mm	HE	1-5	M449	43.09 kg	60 M43 anti-personnel grenades	698 mm	fuze MT M565, MTSQ M548, M577
155 mm	HE	3-5	M483A1	46.53 kg	64 M42 and 24 M46 dual-purpose grenades	803 mm	fuze MTSQ M577
155 mm	HE	4-5	M692	46.49 kg	36 anti-personnel mines‡	803 mm	fuze MTSQ M577
155 mm	HE	4-5	M731	46.49 kg	36 anti-personnel mines**	803 mm	fuze MTSQ M577
155 mm	HE	4-5	M795	46.72 kg	Cast TNT	802 mm	no production plans
155 mm	HERA	3-5	M549 series	43.54 kg	M549 7.25 kg/Comp B M549A1 6.804 kg/TNT	858 mm	fuze PD M557, M739, Prox M732
155 mm	Illuminating	1-3	M118 series	46.26 kg	1.95 kg/illuminant	517 mm	fuze MTSQ M501
155 mm	Illuminating	1-5	M485A2	42.48 kg	2.7 kg/illuminant	602 mm	fuze MT M565



M483A1 155 mm HE projectile



155 mm projectile HE M483A1 (US Army)

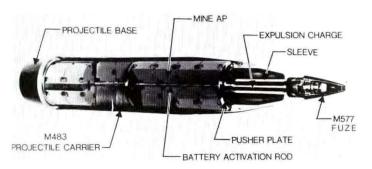
Calibre	Туре	Application	Designation	Weight (projectile)	Weight/type of filling	Length (projectile)	Notes
155 mm	Smoke BE HC and C	1-5	M116 series	42.22 kg	11.72 kg/HC or 8.11 kg/C	594 mm	fuze MTSQ M501
155 mm	Smoke WP	1-5	M110 series	42.32 kg/ 44.4 kg	7.07 kg/WP	602 mm	fuze PD M557, MTSQ M520, M564
155 mm	Smoke WP	4-5	M825	46.72 kg	WP	n/a	production
155 mm	Tactical CS	1-5	M631	43.88 kg	6.37 kg/CS	604 mm	fuze MTSQ M548
155 mm	VX or GB	1-5	M121	44.86 kg	2.72 kg/VX or 2.94 kg/GB	684 mm	fuze PD M557, Prox M514, M728, VX is persistent, GB non-persistent
155 mm	REMBASS	4-5	XM694E1	n/a	sensors	n/a	seismic/acoustic sensor payload
155 mm	Binary	_	M687	42.18 kg	chemical	901 mm	Agent GB2
155 mm	DPICM	_	M864	46.8 kg	submunitions	876.6 mm	production
155 mm	Practice	1-5	M804	42 kg	Smoke	604 mm	Fuzes PD M557, M739, MTSQ M564, M582, Prox M732
155 mm	Training	4-5	M823	62.5 kg	n/a	1371 mm	used to train M712 Copperhead CLGP crews

- 1 M114/M114A1 (towed)
- 2 M44 (self-propelled)
- 3 M109 (self-propelled)
- 4 M109A1 (self-propelled)
- 5 M198 (towed)
- * also known as Remote Anti-Armor Mine System (RAAMS) contains 9 anti-tank mines model M73 which have factory-set long self-destruct time of well over 24 hours
- † also known as Remote Anti-Armor Mine System (RAAMS) contains 9 anti-tank mines model M70 which have factory-set short self-destruct time of under 24 hours
- ‡ also known as Area Denial Artillery Munition (ADAM) carries 36 M67 anti-personnel mines with factory-set long (more than 24 hours) self-destruct time
- also known as Area Denial Artillery Munition (ADAM) carries 36 M72 anti-personnel mines with factory-set short (less than 24 hours) self-destruct time. Artist's impressions of dispensing system used for both RAAMS and ADAM are given in Jane's Military Logistics 1993-94 page 244 (ADAM) and page 264 (RAAMS)

Note: Chemical and tactical nuclear 155 mm projectiles are being destroyed and are no longer operational

There are separate entries elsewhere in this section for the following 155 mm artillery rounds:

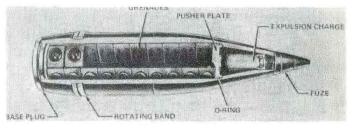
- (1) Martin Marietta Copperhead Cannon-Launched Guided Projectile (CLGP)
- Sense And Destroy Armor Munition (SADARM)
- 155 mm M864 Dual Purpose Improved Conventional Munition (DPICM) (3)
- 155 mm Expendable Jammer XM867.



M692/M731 155 mm HE projectile



M549A1 155 mm rocket-assisted projectile



155 mm projectile HE M449 (US Army)

155 mm Expendable Jammer XM867 AD/EXJAM

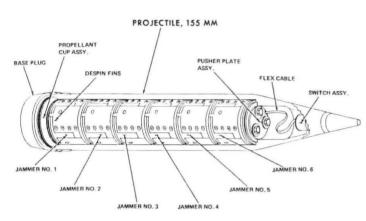
Development/Description

The US Army Electronics Research And Development Command (ERADCOM) is developing an expendable communications jammer that can be loaded five to a 155 mm cargo round and dispensed at preset intervals once the projectile is in flight. The project originated with the

Fairchild Weston division of Schlumberger in conjunction with Harry Diamond Laboratories and the first firings were made at the Yuma Proving Grounds, Arizona, during 1982. Further tests took place at Yuma during FY84 involving 1000 jammers. The jammers are known as 'pucks'. During late 1986 this projectile was type classified as the XM867 AD/EXJAM, based on the M483A1 cargo projectile. Fairchild Weston Systems Inc of Syosset, New York, was awarded a \$15 116 325 development contract in September 1986 to produce the XM867. Loral Control Systems is now responsible for the XM867 system.

A complete system consists of five ECM devices stacked within an M483A1 cargo projectile in the order of preset ejection times; a nose switch assembly, with a P115 reserve battery which is activated during firing; a flex cable connecting the nose switch assembly to a base plug ejection system; an ejection system consisting of an electrically initiated gas generator and a black powder bay containing 5 g of black powder and a standard M577 fuze.

To deliver at a preplanned target area, the M577 fuze air burst time is selected, set and installed on the projectile. Gun elevation and propelling charge are chosen from standard firing tables. Once fired, the spin and setback force provides the means of activating the reserve power supplies in the nose switch assembly and the ECM devices. At the preset time in flight, the fuze explosive output causes mechanical closure of the nose



Cross-section of 155 mm expendable communication jammer

switch. An electrical pulse is sent through the flex cable to the base plug ejection system. The gas generator is activated, igniting the black powder and expelling the base plug of the projectile. The same electrical pulse is inductively sensed by each ECM device and is converted to time zero start for ECM sequencing. The devices are then explosively expelled sequentially at 2.1 second intervals.

As the ECM devices clear the projectile, the three despin fins are deployed by centrifugal force and a drag device is released. The despin fins halt the rotation of the ECM device and the drag device provides the righting force to orientate the jammer for landing upright. The ECM jammer impacts the ground at a velocity of about 40 m/s and uprights itself. Once on the ground, the drag device compartment is explosively removed, the antenna erects and four plane radials are released. Within a few seconds the transmitter is automatically turned on. All device functions are controlled by the internal timing mechanism.

SPECIFICATIONS

JAMMING TYPE DEPLOYMENT SYSTEM PROJECTILE CASE NUMBER OF JAMMING UNITS **DESPIN METHOD** DESPIN TIME

DEPLOYMENT INTERVAL FUZE POWER ANTENNA DEPLOYMENT

TURN ON WEIGHT (projectile) barrage, RF 155 mm artillery standard M483 cargo round

5 per projectile automatically deployed fins and drag device less than 1 s 2 s after first jammer in round is deployed M577 or equivalent reserve battery activated during firing automatic, following cover and drag device

automatic, timed sequence after launch

46.26 kg

Status: Development.

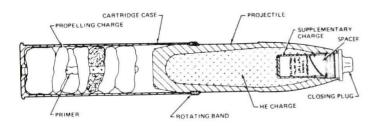
Manufacturer: Loral Control Systems, Kennedy Drive, Archbald,

Pennsylvania 18403, USA.

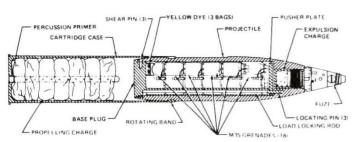
Telephone: (717) 876 1500 Telex: (510) 656 2902

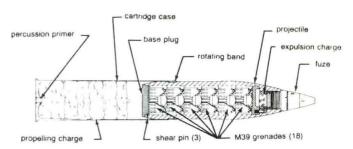
105 mm Ammunition for M101, M102 and M119 Towed Howitzers and M52 and M108 Self-propelled Howitzers (M44 and M108 are no longer in US Army service)

	CATIONS						SV-18 C. II
	Туре	Designation	Weight (complete round)	Weight/type of filling	Length (complete round)	Max muzzle velocity	Notes
	HEAT-T	M662	14.56 kg	0.97 kg Comp B	754 mm	classified	fuze M509A1 PIBD
105 mm	Tactical CS	M629	19.05 kg	3.02 kg CS	817 mm	494 m/s (M102/M108) 472.4 m/s (M101/M52)	fuze MTSQ M548, MT M565
105 mm	HE	M760	18.10 kg	2.08 kg TNT	726 mm	616 m/s	fuze M739, MTSQ M582, Prox M732 (for M119 weapon only)
105 mm	Agent GB	M360	19.89 kg	0.73 kg/GB	792 mm	494 m/s (M102/M108) 472.4 m/s (M101/M52)	fuze PD M739, M557
105 mm	Agent H or HD	M60	19.46 kg	1.43 kg/H, 1.347 kg/HD	789 mm	494 m/s (M102/M108) 472.4 m/s (M101/M52)	fuze PD M557, M739, M51A5
105 mm	APERS-T	M546	17.35 kg	4.148 kg (8000 flechettes)	867 mm	549 m/s	fuze MT M563
105 mm	Blank	M395	2.83 kg	n/a	153 mm	n/a	no fuze
105 mm	Dummy	M14	19.07 kg	n/a	789 mm	n/a	PD Dummy M59
105 mm	HE	M1	18.1 kg	2.08/2.3 kg/Comp B or 1.92/2.177 kg/TNT	789 mm	494 m/s (M102/M108) 472.4 m/s (M101/M52)	fuze PD M557, M78 series; M739 series MTSQ: M582 series, M564; Prox: M513 series, M728, M732
105 mm	HE	M413	19.05 kg	18 M35 anti- personnel grenades	788 mm	494 m/s (M102/M108) 472.4 m/s (M101/M52)	fuze MTSQ M554
105 mm	HE	M444	19.05 kg	18 M39 anti- personnel grenades	788 mm	494 m/s (M102/M108) 472.4 m/s (M101/M52)	fuze MT M565 or MTSQ M548
105 mm	HEP/HEP-T	M327	15.17 kg	3.44 kg Comp A3	739 mm	625 m/s	Fuze BD M91
105 mm	HERA	M548	17.46 kg	2.35 kg/Comp B	830 mm	548 m/s 494 m/s (M102/M108)	Prox M728, PD M739 and M557, MTSQ M564 and M582 MTSQ M501
105 mm	Illuminating	M314 series	21.06 kg	0.78 g/illuminant	817 mm	472.4 m/s (M101/M52) 494 m/s (M102/M108)	MTSQ M501
105 mm	Leaflet	M84B1	18 kg	leaflets	774 mm	433 m/s	fuze MTSQ 501
105 mm	Smoke	M60 series	19.46 kg	1.75 kg/WP	790 mm	494 m/s (M102/M108) 472.4 m/s (M101/M52)	fuze PD M557, MTSQ M564
105 mm	Smoke	M84 series	19.03 kg	5.57 kg/HC	774 mm	494 m/s (M102/M108) 472.4 m/s (M101/M52)	fuze MT M565, MTSQ M548 M501
105 mm	TP-T	M67	16.81 kg	1.76 kg/inert	788 mm	381 m/s	empty fuze
105 mm	HE RAP	M913	n/a	TNT	n/a	n/a	for M119 (qv)
105 mm	HE RAP	XM927	n/a	TNT	n/a	n/a	development (qv)



105 mm cartridge HE M1 (US Army)





105 mm cartridge HE M444 (US Army)

105 mm cartridge HE M413 (US Army)

105 mm High Explosive Rocket-Assisted Projectile M913

Designed for use with the 105 mm M119 Light Howitzer, the M913 105 mm High Explosive Rocket-Assisted (HERA) projectile provides over a 40 per cent range increase and a significant increase in lethality, over the standard 105 mm M1 projectile.

The increased range is accomplished through the use of a composite propellant rocket motor that is designed to survive high 'G' and high spin environment which functions 16 seconds after leaving the gun tube giving the greatest range extension.

The XM927 is a direct variant of the US Army's new 105 mm M913 HERA projectile and utilises the same projectile and rocket motors as the M913 but with a reduced propelling charge. This reduced propelling charge allows the XM927 to be used in all M101, M102 and M119 105 mm howitzers. The XM927 is expected to be type classified in 1993.

Type	M913	XM927		
CALIBRE	105 mm	105 mm		
CARTRIDGE CASE	M14B4	M14B4		
PRIMER	M28B2	M28B2		
FUZES	M739 PD, M582	MT, M732A2 VT and M762 ET		
PROPELLING CHARGE	M229	M67 (zone 7)		
EXPLOSIVE CHARGE	TNT	TNT		
WARHEAD BODY	HF-1	NF-1		
MOTOR BODY	4340 steel with welded band			
ROCKET PROPELLANT	HTPB (aluminise	ed)		
IGNITION DELAY RANGE	pyrotechnic	pyrotechnic		
rocket on (max)	19 500 m	14 600 m (M101)		
		16 500 m (M102/M119)		
rocket off (max)	14 400 m	10 600 m (M101)		
Transition of the state of the		11 500 m (M102)		

11 900 m (M119)

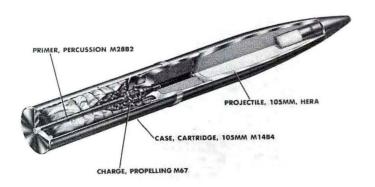
98%

Status: 105 mm M913 - type classified.

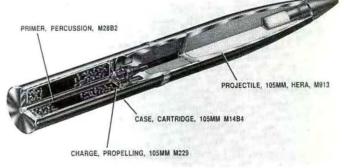
RELIABILITY (excl fuze)

105 mm XM927 - expected to be type classified in 1993.

98%



Cutaway drawing of 105 mm XM927 HERA



Cutaway drawing of 105 mm M913 HERA

20 mm Fixed Ammunition

Listed below is a résumé of current 20 mm fixed ammunition some of which may still be used by the United States forces.

SPECIFICATIONS

Туре	Designation (complete round)	Designation (projectile)	Fuze	Designation (cartridge case)	Designation (primer)	Application
API	M53	M53	none	M103 brass, M103A1 steel	M52A3B1	M39, M61
API-T	M601	M602	none	M187 steel	M103	M139
AP-T	M95*	M95	none	M21A1 copper alloy	M36A1	M3
Dummy	M51A2	M51A2	none	M103A1 steel	no primer	M39, M61, M168
HEI	M56A1	M56A3 or M56A4	PD M505A3	M187 steel	M52A3B1	M39, M61, M168
HEI	M97A2	M97A2	PD M505A3	M21A1 copper alloy	M52A3B1	M24A1
HEI	M210	M97A2	PD M505A3	M21A1 copper alloy	M36A2	M3
HEI-T	M242	M242	PD M505A3	M103 brass, M103A1 steel	M52A3B1	M39, M61
HEI-T	M246	none	PD M505A3	M103 brass, M103A1 steel	M52A3B1	M168
HPT	M54A1	M54A1	none	M103 brass, M103A1 steel	M52A3B1	M39, M61, M168
Incendiary	M96*	M96	none	M21A1 copper alloy	M36A1	M3

Type	Designation (complete round)	Designation (projectile)	Fuze	Designation (cartridge case)	Designation (primer)	Application
TP	M55A2	M55A2/M55A3/M55A3B1	none	M21A1 copper alloy	M52A3B1	M39, M61
TP	M99A1	M99A1	none	M21A1 copper alloy	M52A3B1	M24A1
TP	M204	M99A1	none	M21A1 copper alloy	M35A2	M3
TP-T	M206A1	M212A1	none	M204 steel	M113	M139
TP-T	M220	M221	none	M103 brass, M103A1 steel	M52A3B1	M39, M61, M168

^{*} for contingency use only

Notes on application: M3, M24A1 and M39 are aircraft cannon, M61 is Vulcan cannon which can be aircraft- or helicopter-mounted, M139 was main armament of some versions of M114 command and reconnaissance vehicle now phased out of service, M168 is Vulcan cannon-mounted in M163 SPAAG system (on M113A1 chassis), and in towed M167 anti-aircraft gun system.

Olin 20 mm Ammunition

Olin is the leading manufacturer of 20 mm M50 series ammunition used in the M61, M197 and M39 gun systems and has so far produced in excess of 150 million rounds for the home and export markets.

In addition to the three rounds covered, it has also developed the 20 mm M940 multipurpose tracer self-destruct (MPT-SD) round as the replacement for the M246 HEI-T-SD.

According to Olin, the M940 MPT-SD has increased lethality against targets approaching that of a 25 mm HEI projectile, 25 per cent reduction in time-of-flight to 1800 m, inherent detonation delay to carry terminal effectiveness inside of the target, excellent graze sensitivity and bright red tracer for improved visual tracking.

SPECIFICATIONS			
DESIGNATION	M53	M55	M56
CALIBRE	20 mm	20 mm	20 mm
TYPE	API	TP	HEI
LENGTH	168 mm	168 mm	168 mm
WEIGHT	260 g	260 g	260 g
MUZZLE VELOCITY			
(at 23.77 m)	1027 m/s	1027 m/s	1027 m/s
ARMOUR-PIERCING			
CAPABILITY	nil	nil	20 mm/100 m*

^{*} at an angle of 25°

Status: In production for home and export markets.

Manufacturer and sales headquarters: Olin Ordnance. 10101 Ninth Street North, St Petersburg, Florida 33716, USA Telephone: (813) 578 8100 Fax: (813) 578 8128

Alliant Techsystems Lightweight 30 mm Ammunition

Development/Description

Alliant Techsystems designed, developed and put into high volume production the lightweight 30 mm ammunition family under various contracts with Hughes Helicopters (now McDonnell Douglas Helicopter), the US Army Research and Development Center and the US Army Production Base Modernization. The family of lightweight 30 mm ammunition includes the M788 TP, M789 HEDP, and the M799 HEI. The M799 HEI was developed for US Marine Corps use. The M788 and M789 are both classified as Standard A.

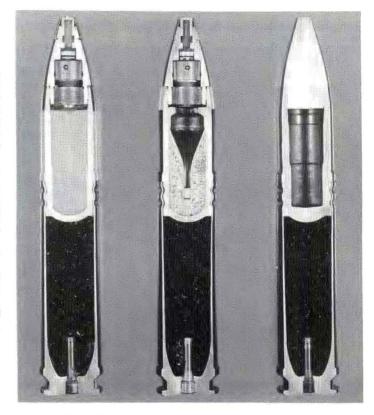
Alliant Techsystems 30 mm ammunition is fired from five types of weapon, the M230 Chain Gun, the ADEN Mk IV cannon, the French DEFA cannon, the 30 mm Heavy Support Weapon and the ASP-30. The rounds are fixed, aluminium-cased and electrically primed. The ammunition is loaded with a PA 250 low voltage primer, a flashtube with three ignition pellets and 50 g of WC 855 ball propellant. The projectiles are fired at a nominal muzzle velocity of 805 m/s and maximum range is 4000 m.

The M788 TP projectile consists of an inert, impact-extruded steel projectile body with a gilded metal rotating band and a pressed-on aluminium nose. The M789 projectile has a heat-treated steel body and is loaded with 27 g of PBXN-5 explosive. It has a fluted copper shaped-charge liner, a steel retaining ring and a threaded-on M759 point detonating fuze. The fuze, formerly designated the XM714E6, is made by Alliant Techsystems and has dual safety, arming delay and graze function. It is 47.8 mm long, weighs 40 g and is made of aluminium.

SPECIFICATIONS

Type	HEDP	TP
DESIGNATION	M789	M788
CALIBRE	30 mm	30 mm
WEIGHT		
cartridge	350.5 g	352,8 g
projectile	236.6 g	238.7 g
explosive	27 g	none
LENGTH		
cartridge	199.75 mm	199.75 mm
projectile	108.07 mm	107.5 mm
MUZZLE VELOCITY (nominal)	805 m/s	805 m/s
FUZE	M759 PD	none

Status: Production. In service with US Army.



Cross-section of Alliant Techsystems Lightweight 30 mm ammunition (left to right) M799 HEI; M789 HEDP; M788 TP

Manufacturers: Alliant Techsystems, 7225 Northland Drive, Brooklyn Park, Minnesota 55428, USA.

Telephone: (612) 536 4544 Fax: (612) 536 4545

Olin Corporation, 120 Long Ridge Road, Stamford, Connecticut 06904, USA.

25 mm Ammunition

Development/Description

The 25 mm ammunition family currently in production includes these four rounds: M791 APDS-T, M792 HEI-T, M793 TP-T and the M910 TPDS-T. There is a separate entry for the new M919 APFSDS-T round.

This series of 25 mm ammunition was designed primarily for use in the M242 Chain Gun installed in the M2 Infantry Fighting Vehicle and the M3 Cavalry Fighting Vehicle but can also be used with the Oerlikon-Contraves KBA-BO2 cannon and the General Electric GE525 Gatling gun. It is also used with the Light Armored Vehicle (LAV) and is used with US Marine Corps AV-8B Harrier GAU-12 gun. It has also been adopted by Spain for its VEC (6 × 6) Cavalry Scout Vehicles.

All rounds are steel cased and have tracers. The M793 TP-T has an inert, impact-extruded steel projectile with a steel band and a pressed-on aluminium nose cap. The M792 HEI-T also has an impact-extruded steel projectile with a steel band. It is charged with PBXN-5/aluminium explosive and has an M758 PDSD fuze. The M758 weighs 18.7 g and has dual safety, arming delay and graze functions. The M791 APDS-T projectile has a windscreened tungsten penetrator and an aluminium pusher in a moulded, glass-filled nylon sabot.

The M910 TPDS-T is a recently developed training round designed to specifically match the trajectory of the armour-piercing round to a limited

SPECIFICATIONS				
Type	APDS-T	HEI-T	TP-T	TPDS-T
DESIGNATION	M791	M792	M793	M910
CALIBRE	25 mm	25 mm	25 mm	25 mm
WEIGHT				
cartridge	457 g	493 g	492 g	426 g
projectile	133 g	185 g	182 g	95 g
explosive	none	30 g	none	none
LENGTH				
cartridge	221 mm	218 mm	218 mm	223 mm
projectile	99 mm	117 mm	117 mm	75 mm
MUZZLE				
VELOCITY	1345 m/s	1100 m/s	1100 m/s	1540 m/s
FLIZE	none	M758 PDSD	none	none

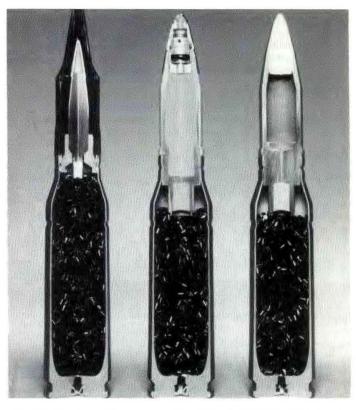
Manufacturers: In recent years, production contracts for this 25 mm range of ammunition have been on a competitive basis, with two companies competing

Alliant Techsystems Inc, 7225 Northland Drive, Brooklyn Park, Minnesota 55428, USA

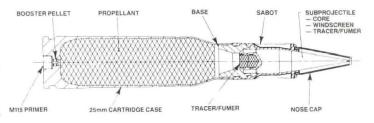
Telephone: (612) 536 4544 Fax: (612) 536 4545

Aerojet Ordnance Company, 9236 East Hall Road, Downey, California

Telephone: (310) 923 7511 Telex: 673599 Fax: (310) 904 7914



Alliant Techsystems 25 mm ammunition (left to right) M791 APDS-T, M792 HEI-T, M793 TP-T

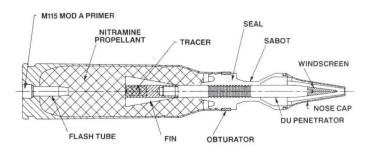


25 mm M910 TPDS-T projectile cutaway to show main components

25 mm M919 APFSDS-T Ammunition

Development/Description

In 1990 Aerojet Ordnance was awarded a contract from the US Army to commence Low Rate Initial Production (LRIP) of the 25 mm M919 APFSDS-T round for use with the M242 Chain Gun. The initial contract is worth \$18.5 million and covers the supply of an initial 110 000 rounds with options for an additional 360 000 and 640 000 rounds. The contract was awarded by the US Army Armament Research and Development Command at Picatinny Arsenal.



25 mm M919 APFSDS-T round cutaway to show key components

Aerojet Ordnance entered a Full-Scale Engineering Development (FSED) programme for this round in 1986. The company is already producing the companion training round, the M910 TPDS-T.

The company will produce the M919's heavy metal penetrator at its Jonesborough, Tennessee facility. Projectile assembly and the load/ assembly/pack process and testing will be completed at Chino, California. Manufacture of the sabot and programme management will be at Downey, California.

SPECIFICATIONS

CALIBRE	25 mm
WEIGHT	
cartridge	455 g
primed case	224 g
projectile	132 g
sub-projectile	96 g
propellant	97 g
CARTRIDGE LENGTH	233 mm
MUZZLE VELOCITY	1420 m/s
CHAMBER PRESSURE	454 MPa

Manufacturer: Aerojet Ordnance Company, 9236 East Hall Road, Downey, California 90241, USA

Telephone: (310) 923 7511 Telex: 673599 Fax: (310) 904 7914

Aerojet 30 mm Ammunition

30 mm × 173 Mauser Model F

Aerojet is producing a family of 30×173 mm ammunition for use with the Mauser Model F cannon. This ammunition family of steel cased TP-T, APDS-T and HEI-SD-T rounds is based upon technology and production experience gained from the US Air Force's GAU-8/A programme.

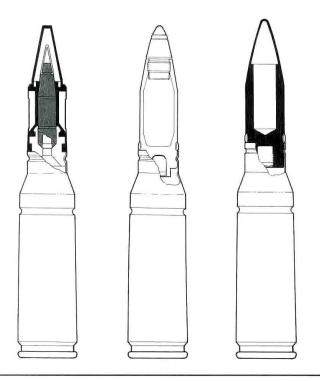
SPECIFICATIONS			
Туре	APDS-T	HEI-SD-T	TP-T
ROUND LENGTH	258 mm	290 mm	290 mm
WEIGHT			
round	707 g	670 g	670 g
projectile	255 g	363 g	363 g
PENETRATOR TYPE	tungsten	n/a	n/a
CARTRIDGE CASE TYPE	steel	steel	steel
MUZZLE VELOCITY	1225 m/s	1035 m/s	1035 m/s
TIME OF FLIGHT			
to 2000 m	1.87 s	2.7 s	2.7 s

^{&#}x27;self-destruct time 7.9 s

Manufacturer: Aerojet Ordnance, 9236 East Hall Road, Downey, California 90241, USA.

Telephone: (310) 923 7511 Telex: 673599 Fax: (310) 904 7914

Aerojet 30 mm × 173 Mauser Model F ammunition, from left to right, APDS-T, HEI-SD-T and TP-T



30 mm GAU-8/A Ammunition

The Aerojet Ordnance 30 mm GAU-8/A ammunition was developed by Aerojet Ordnance and qualified by the US Air Force, over 90 million rounds have been delivered to date. The ammunition is used with the GAU-8/A seven barrel Gatling-type gun used on the US Air Force's A10 aircraft. The cartridge case was the first production application of a lightweight aluminium cartridge case in a high performance gun. Plastic rotating bands are used which results in a threefold increase in barrel life. Data for the rounds are as follows:

Manufacturer: Aerojet Ordnance, 9236 East Hall Road, Downey, California 90241, USA.

Telephone: (310) 923 7511 Telex: 673599 Fax: (310) 904 7914

Alliant Techsystems Inc, 7225 Northland Drive, Brooklyn Park, Minnesota 55428, USA.

Telephone: (612) 536 4795 Fax: (612) 536 4545

SPECIFICATIONS

Type	API	HEI	TP
DESIGNATION	PGU-14/B	PGU-13/B	PGU-15/B
ROUND LENGTH	290 mm	290 mm	290 mm
WEIGHT			
round	727 g	662 g	667 g
projectile	425 g	360 g	365 g
MUZZLE VELOCITY	983 m/s	1021 m/s	1018 m/s

Ammunition for 40 mm M1* LAAG and 40 mm M42* SPAAG

*no longer used by US Army

Calibre	Туре	Designation	Weight (complete round)	Weight/type of filling	Length (complete round)	Max muzzle velocity	Notes
40 mm	AP-T	M81/M81A1	2.077 kg	none	447 mm	872 m/s	no fuze
40 mm	Dummy	M25	2.154 kg	none	447 mm	n/app	dummy fuze or M69/M69B1
40 mm	HEI-T	Mk 2	2.154 kg	0.06 kg/TNT or Tetryl	447 mm	880 m/s	fuze PD M3/M3A1
40 mm	HE-T	Mk 2	2.154 kg	as above	447 mm	880 m/s	fuze PD M3/M3A1
40 mm	TP-T	M91	2.14 kg	none	447 mm	872 m/s	dummy fuze or M69/M69B1
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Ammunition for 76 mm Gun M32 on M41 Tank*

*no longer used by US Army

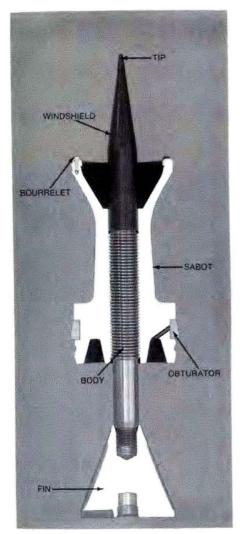
Calibre	Туре	Designation	Weight (complete round)	Weight/type of filling	Length (complete round)	Max muzzle velocity	Notes
76 mm	AP-T	M339	12.39 kg	none	835 mm	954 m/s	no fuze, training equivalent is M340/M340A1
76 mm	Blank	M355A2	1.96 kg	none	168 mm	n/a	cartridge only
76 mm	Canister	M363	12.33 kg	4.08 kg/steel balls	814 mm	716 m/s	no fuze
76 mm	HE	M352	11.57 kg	0.66 kg/Comp B	865 mm	716 m/s	fuze PD or MTSQ
76 mm	HEAT-T	M496	11.71 kg	0.49 kg/Comp B	807 mm	1082 m/s	fuze PIBD M509A1
76 mm	HVAP-DS-T	M331A1 M331A2	9.38 kg	none	784 mm	1231 m/s	no fuze
76 mm	HVAP-T	M319	8.63 kg	none	828 mm	1234 m/s	no fuze, training equivalent is M320
76 mm	Smoke WP	M361/M361A1	11.71 kg	0.62 kg/WP	865 mm	713.5 m/s	fuze M48A3 (M361), fuze M521 (M361A1)
76 mm	APFSDS-T	M464	8.5 kg	1.63 kg/tungsten	705 mm	1480 m/s	developed by AAI as private venture for export market (qv)

Ammunition for 90 mm Gun on M47 and M48 Tanks and M56 SPATG (none of these are now in service with the US Army)

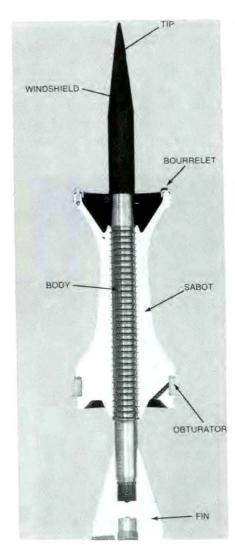
Calibre	Туре	Designation	Weight (complete round)	Weight/type of filling	Length (complete round)	Max muzzle velocity	Notes
90 mm	APERS-T	M580	18.71 kg	2.04 kg, 4200 flechettes	966 mm	914.4 m/s	MT M711
90 mm	AP-T	M77	19.06 kg	none	831 mm	821 m/s	no fuze
90 mm	APC-T	M82	19.39 kg/19.89 kg	0.14 kg/Expl D	971 mm	790 m/s	fuze BD M68/M68A1
90 mm	Blank	M394	3.73 kg	none	185 mm	n/a	cartridge only
90 mm	Canister	M336	18.86 kg	1281 pellets	858 mm	858 m/s	no fuze
90 mm	Canister	M377	17.82 kg	3.08 kg, 5600 flechettes	864 mm	851 m/s	no fuze
90 mm	Dummy	M12 series	19.06 kg/19.25 kg	none	950 mm	n/a	fuze M80
90 mm	HEAT	M348/M348A1	15.78 kg	0.7 kg/Comp B	857 mm	832 m/s	fuze PIBD M509A1
90 mm	HEAT-T	M431 series	14.96 kg	0.54 kg/Comp B	914 mm	1216 m/s	fuze PIBD M509A1
90 mm	HE	M71	18.68 kg/19.01 kg	0.97 kg/Comp B	951 mm	730 m/s	fuzes PD M51A5 or M557, MTSQ M520 or M564
90 mm	HE-T	M71A1	17.6 kg/17.93 kg	0.97 kg/Comp B	951 mm	823 m/s	fuzes PD M51A5 or M557, MTSQ M520 or M564
90 mm	HVAP-T	M332A1	14.65 kg	none	912 mm	1165 m/s	no fuze
90 mm	Smoke WP	M313	19.29 kg	0.89 kg/WP	950 mm	821 m/s	fuzes PD M48A3 or M57, MTSQ M501 series
90 mm	Smoke WP	M313C	18.37 kg	0.89 kg/WP	951 mm	730 m/s	fuzes PD M48A3 or M57, MTSQ M501 series
90 mm	AP-T	M318	19.94 kg	none	950 mm	851 m/s	no fuze
90 mm	AP-T	M318A1	19.91 kg	none	942 mm	912 m/s	no fuze
90 mm	TP-T	M353 series	19.91 kg	none	939 mm	914 m/s	no fuze

Ammunition for 105 mm Gun on M60, M60A1, M60A3, M48A5 and M1 Tanks

Calibre	Type	Designation	Weight (complete round)	Weight/type of filling	Length (complete	Max muzzle velocity	Notes
105 mm	APDS-T	M392	18.6 kg	none	round) 838 mm	1458 m/s	British manufacture
105 mm	APDS-T	M392A2	18.6 kg	none	838 mm	1458 m/s	US manufacture
105 mm	APDS-T	M728	18.91 kg	none	838 mm	1426 m/s	no fuze









105 mm M774 APFSDS-T projectile which utilises one-piece (monobloc) depleted uranium penetrator

105 mm M833 APFSDS-T projectile which utilises one-piece (monobloc) depleted uranium penetrator

158 AMMUNITION / USA

Calibre	Туре	Designation	Weight (complete round)	Weight/type of filling	Length (complete round)	Max muzzle velocity	Notes
105 mm	APFSDS-T	M735	17.91 kg	none	963 mm	1501 m/s	no fuze, has 35 mm tungsten alloy penetrator
105 mm	APFSDS-T	M774	17.14 kg	none	908 mm	1508 m/s	standardised in 1979, replaced M735 in production, DU projectile weight 5.775 kg
105 mm	APFSDS-T	M833	17.3	none	998 mm	n/a	no fuze, has monobloc staballoy penetrator, projectile weight 6.197 kg
105 mm	APFSDS-T	M900	n/avail	none	n/av	1500 m/s	DU penetrator with weight of 6.83 kg
105 mm	APERS-T	M494	24.94 kg	4.17 kg flechettes	995 mm	821 m/s	fuze MT M571
105 mm	Dummy	M457	19.95 kg	none	939 mm	n/a	no fuze
105 mm	HEAT-T	M456/M456A2	21.78 kg	0.97 kg/Comp B	990 mm	1173 m/s	fuze PIBD M509A1
105 mm	Smoke WP	M416	20.63 kg	2.72 kg/WP	939 mm	730.5 m/s	BD M534
105 mm	TP-T	M467	20.42 kg	none	939 mm	730 m/s	no fuze
105 mm	TP-T	M490/M490A1	20.41 kg	none	990 mm	1170 m/s	no fuze
105 mm	TPDS-T	M724	14.51 kg	none	838 mm	1539 m/s	British manufacture
105 mm	TPDS-T	M724A1	14.51 kg	none	838 mm	1539 m/s	US manufacture
105 mm	TPDS-T	M737	9.44 kg	none	838 mm	1539 m/s	in service
105 mm	HEP-T	M393 series	20.41 kg	2.93 kg/Comp A3	940 mm	731.5 m/s	fuze BD M534A1 (M393A1) BD M578 (M393A2)
105 mm	KE	XM872	n/a	none	n/a	n/a	Rocket-Assisted Kinetic Energy: under development

Note: The latest 105 mm APFSDS-T round is the M900 which has a depleted uranium penetrator with a muzzle velocity of 1500 m/s. Projectile length is 711 mm and weighs 6.83 kg. There is a separate entry under AAI in this section for the private venture 105 mm High Explosive Air Defence (HEAD) round. Details of the private venture Olin 105 mm C76A1 (FP105) and C127 are given in the earlier entry for Olin

Ammunition for 120 mm M256 Gun fitted in M1A1/M1A2 Tank

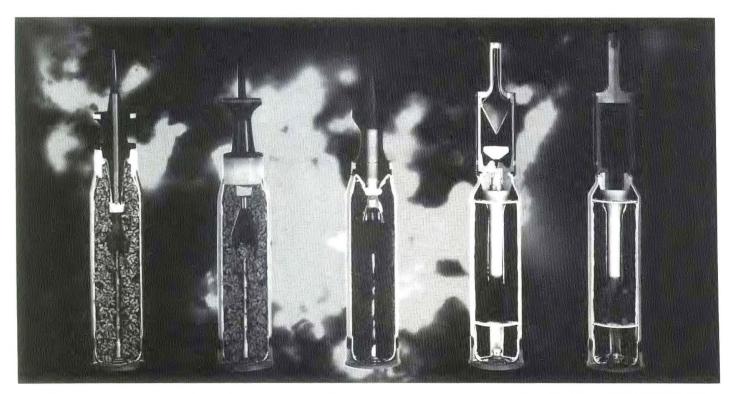
DESIGNATION TYPE	M829 APFSDS-T	M830 HEAT- MP-T	M831 TP-T	M865 TPCSDS-T
WEIGHT (complete				
round)	18.7 kg	24.2 kg	24.2 kg	19 kg
LENGTH (complete round) PROPELLANT WEIGHT (propellant) CHAMBER PRESSURE LENGTH (projectile) WEIGHT (projectile) MUZZLE VELOCITY RANGE	935 mm JA-2 8.1 kg 5100 bar 615 mm 7.16 kg 1675 m/s 3000 m +	981 mm stick 5.4 kg 4800 bar 842 mm 13.5 kg 1140 m/s 2500 m	981 mm stick 5.4 kg 4800 bar 842 mm 13.5 kg 1140 m/s 2500 m	881 mm single base 8.3 kg 4850 bar 468.5 mm 3.2 kg 1700 m/s 3000 m

Development/Production

The four 120 mm M256 gun rounds currently in production by Alliant Techsystems are the M829 APFSDS-T, the M865 TPCSDS-T, the M831 TP-T and the M830 HEAT-MP-T.

Alliant Techsystems is the Principal Systems Manager under the guidance of US AMCCOM at Rock Island and are currently under contract for the development of next generation chemical and kinetic energy rounds for the 120 mm gun system. More recently the enhanced M829A1 and M830A1 have entered production for use with the M1A1/M1A2 MBTs.

Alliant Techsystems, as part of the FY86 production programme, was given a contract to train a selected US Government second source (the former General Defense Corporation) for 120 mm tank ammunition. As part of this process Alliant Techsystems agreed to a \$1 million per month penalty if the second source contractor did not deliver their first lots of ammunition on schedule. All rounds were delivered by the second source per the required schedule.



Alliant Techsystems 120 mm ammunition family for M1A1 Abrams MBT, from left to right, M829 APFSDS-T, KE-T, M865 TPCSDS-T, M830 HEAT-MP-T and M831 TP-T

Description

These 120 mm rounds are interoperable with the 120 mm smooth-bore gun installed in the Leopard 2 MBTs. The rounds consist of the projectile and the cartridge case.

The common Combustible Cartridge Case (CCC) structurally combines major ammunition components prior to firing and is completely consumed during the propellant function. All that remains is the spent cartridge case material.

Obturation, the sealing of propulsion gases behind the projectile, is achieved by a band (nylon on KE and copper on HEAT) round the rear portion of the stabilised projectile.

New Generation 120 mm Tank Ammunition

The latest 120 mm tank rounds to enter production are the M829A1 APFSDS-T which were used during the 1991 Desert Storm operation and are known as the Silver Bullet and the M830A1 HEAT-MP-T round.

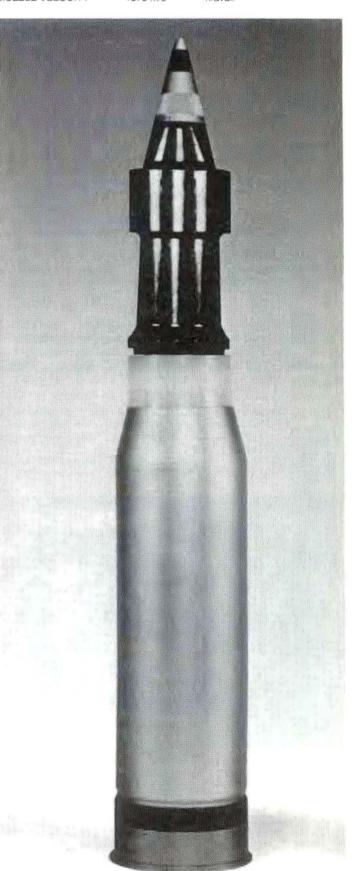
The M829A1 has been designed as the replacement for the M829 and features a redesigned projectile and improved propulsion system for increased penetration characteristics.

The M830A1 has been designed as the replacement for the M830

HEAT-MP-T round and contains certain properties of the HEAT round but is fitted with a sabot and has a new fuzing system.

SPECIFICATIONS		
Designation	M829A1	M830A1
Type	APFSDS-T	HEAT-MP-T
CARTRIDGE		
LENGTH	984 mm	982 mm
WEIGHT	20.9 kg	22.3 g
TYPE (propellant)	JA2 19 Perf	JA2 19 Perf
PROPELLANT	7.9 kg	11.4 kg
WEIGHT (projectile)	9.0 kg	7.1 kg
MUZZLE VELOCITY	1575 m/s	n/avail





120 mm M829A1 APFSDS-T round which has a longer penetrator than the earlier M829 round

120 mm M830A1 HEAT-MP-T round which has a sabot and new fuzing system

Alliant Techsystems 120 mm KE-T Round

Development/Description

The 120 mm KE-T (Kinetic Energy-Tungsten) round has been developed by Alliant Techsystems as a private venture and was announced for the first time in 1988.

Teamed with Alliant Techsystems are NWM de Kruithoorn of the Netherlands for the penetrator and Chamberlain Manufacturing Company of the USA who provided the sabots, fins and projectile assembly facility

The training round for the KE-T would be the standard US Army M865

It has been developed specifically for the export market in support of export sales of the 120 mm armed M1A1/M1A2 Abrams MBT as the US Government will not allow sales of the standard M829 APFSDS-T round which has a DU penetrator.

The KE-T is ballistically matched to the M829 and has a three-part sabot. length-to-diameter ratio of about 20: 1 and six fins with a tracer element.

SPECIFICATIONS

CALIBRE 120 mm LENGTH COMPLETE ROUND 983 mm WEIGHT COMPLETE ROUND 18.7 kg

JA-2 'solventless' PROPELLANT TYPE

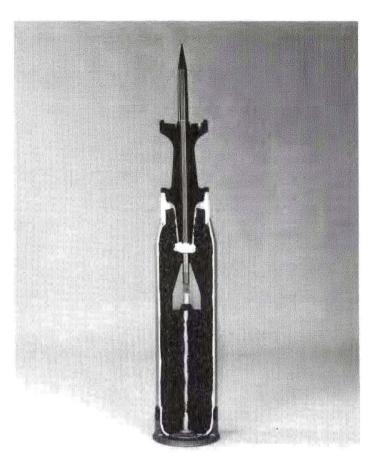
PROPELLANT WEIGHT 8.1 kg CHAMBER PRESSURE 5100 bar PROJECTILE LENGTH 658 mm WEIGHT 7.16 kg MUZZLE VELOCITY 1690 m/s RANGE 3000 m +

Status: Development complete. Ready for production. First production deliveries could be made within a year of a firm order being placed.

Manufacturer: Alliant Techsystems Inc, 7225 Northland Drive, Brooklyn

Park, Minnesota 55428, USA.

Telephone: (612) 536 4558 Fax: (612) 536 4545

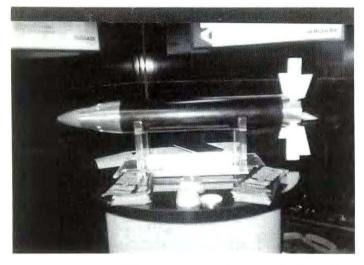


Private venture Alliant Techsystems 120 mm KE-T round cutaway to show interior

Hercules 120 mm X-ROD Autonomous Tank Round

Following a competition between AAI and Hercules Defense Electronics Systems Inc, the latter was selected in May 1992 as the contractor to continue development of the 120 mm X-ROD autonomous kinetic energy smart munition for the M1A1/M1A2 MBT.

Funding for this programme comes from the US Department of Defense's Balanced Technology Initiative (BTI) office and the Defense Advanced



Hercules 120 mm X-ROD autonomous tank round with fins unfolded (Christopher F Foss)

Research Program Agency (DARPA). The programme is managed by the Army Research and Development Center (ARDEC).

Hercules Defense Electronics Systems is providing overall programme management and systems integration for the programme in addition to developing the front end guidance and control systems. The Hercules Allegany Ballistics Laboratory is providing propulsion engineering and development.

The X-ROD has been under development since 1987 and combines Millimeter Wave guidance technology with rocket-assisted propulsion to provide armour forces with an autonomous fire-and-forget capability.

The Hercules X-ROD requires no changes to the M1A1/M1A2 firecontrol system and is completely compatible with the tank's fire-contol system.

According to Hercules it provides a substantial enhancement to both lethality and accuracy at ranges well beyond present day tank engagements.

When fired, the MMW guidance package provides in-flight multiple manoeuvres to ensure a target for a centroid hit. A rocket-assisted boost prior to impact provides a penetrator with the hypervelocity required to defeat any current and emerging tank threats.

As the X-ROD requires no update from the tank after launch, maximum fire rates are achieved, so minimising exposure to opposing forces. The MMW guidance also provides X-ROD resistance to electronic countermeasures.

The X-ROD 120 mm projectile has a nose-mounted MMW sensor with the guidance electronics, battery and manoeuvre mechanism to the rear. The projectile has a composite case which contains the rocket propellant and the penetrator which also extends to the rear where there are eight fins which unfold after launch. In flight the missile is steered through impulse thrusters mounted around the nose.

Status: Development.

Manufacturer: Hercules Defense Electronics Systems Inc. PO Box 4648, Clearwater, Florida 34618, USA.

Telephone: (201) 770 2526

Ammunition for 152 mm Gun in M551 Sheridan Light Tank

Calibre	Туре	Designation	Weight (complete round)	Weight/type of filling	Length (complete round)	Max muzzle velocity	Notes
152 mm	Canister	M625A1	21.99 kg	6.89 kg, 10 000 flechettes	487 mm	688 m/s	no fuze
152 mm	Dummy	M596	23.13 kg	none	675 mm	n/a	no fuze
152 mm	HE-T	M657	21.12 kg	4.3 kg/TNT	624 mm	683 m/s	fuze PD M720
152 mm	HEAT-T-MP	M409 series	22 kg	2.85 kg/Comp B	686 mm	683 m/s	fuze PIBD M539
152 mm	TP-T	M411 series	22.12 kg/22.58 kg	0.136 kg/TNT	678 mm	683 m/s	fuze M557 (M411 only)

YUGOSLAVIA (SERBIA/MONTENEGRO)

Yugoslav Ammunition

The Yugoslav defence industry produces a range of artillery and small arms ammunition to suit the weapons produced both for the Yugoslav armed forces and for export. Owing to the situation in the former Yugoslavia as of early 1993, it is not certain which ammunition factories are currently in production. The list below covers ammunition being offered for export by Yugoslavia prior to the recent conflict.

20 mm Ammunition for M55 and M75 Anti-aircraft Guns

This ammunition is used with the triple-gun installations of the 20 mm M55 anti-aircraft guns and the M75 single-barrel gun. The gun involved is the Hispano-Suiza HSS 804 cannon. In addition to the rounds outlined below a Drill round and a Blank is also available. The ammunition is also fired from the 20 mm cannon installed in the BVP M80A and M-980 MICVs

SPECIFICATIONS Type DESIGNATION WEIGHT	HEI-T	HEI	API	API-T	AP-T	TP-T	TP	HE-T	HE-T	HE	AP
	M57	M57	M60	M60	M60	M57	M57	M57	M57	M57	M60
complete projectile LENGTH	261 g 137 g	257 g 132 g	274 g 142 g	274 g 142 g	274 g 142 g	261 g 137 g	257 g 132 g	261 g 137 g	257 g 132 g	257 g 132 g	274 g 142 g
complete	184 mm	184 mm	182 mm	182 mm	182 mm	184 mm	182 mm				
projectile	92 mm	92 mm	81 mm	81 mm	81 mm	92 mm	81 mm				
MUZZLE VELOCITY	850 m/s	850 m/s	840 m/s	840 m/s	840 m/s	850 m/s	840 m/s				

The brass cartridge cases contain 31 to 33 g of propellant and a self-destruct fuze acts between 4.5 and 9.5 seconds.

20 mm Ammunition for Oerlikon Mk 4

Ammunition produced for the Oerlikon Mark 4 cannon includes the following types:

Type DESIGNATION WEIGHT	HEI-T M62	HE-T M62	AP-T M63	API M63	TP-T M62	API-T M63	AP M63	HEI M63	HE M62	TP M62
complete projectile LENGTH	246 g 122 g	246 g 122 g	265 g 142 g	265 g 142 g	246 g 122 g	265 g 142 g	265 g 142 g	246 g 122 g	246 g 122 g	246 g 122 g
complete projectile MUZZLE VELOCITY	184 mm 86 mm 845 m/s	184 mm 86 mm 845 m/s	182 mm 81 mm 844 m/s	182 mm 81 mm 844 m/s	184 mm 86 mm 845 m/s	182 mm 81 mm 844 m/s	182 mm 81 mm 844 m/s	184 mm 86 mm 845 m/s	184 mm 86 mm 845 m/s	184 mm 86 mm 845 m/s



Yugoslav 20 mm round HEI-T M62

23 mm Ammunition ZU-23 and ZSU-23-4

Yugoslavia produces ammunition for the ZU-23 towed and ZSU-23-4 self-propelled air defence systems. It also produces ammunition for 23 mm aircraft cannon. Details of the ammunition for the ZU-23 and ZSU-23-4 are given here.

Туре	API and API-T	HE and HEI	HEI-T and HE-T	TP and TP-T
DESIGNATION WEIGHT	M85	M85	M85	M85
complete projectile LENGTH	436 g 190 g	436 g 182 g	436 g 190 g	436 g 190 g
complete projectile MUZZLE VELOCITY	236 mm 100.2 mm 970 m/s	236 mm 108.1 mm 970 m/s	236 mm 108.1 mm 970 m/s	236 mm 108.1 mm 970 m/s

30 mm Ammunition

Yugoslavia currently produces at least five types of 30 mm ammunition, the HEI M68/TP M68 for the twin 30 mm self-propelled (4 \times 4) system designed and built in Yugoslavia and the 30 mm HE-T M69/TP M69 and Blank M78 for the Czech and Slovakian twin 30 mm 53/59 (6 \times 6) SPAAG. The ammunition is also fired by the 30 mm cannon installed in the BVP M80AK IEV

TYPE DESIGNATION WEIGHT	HEI/TP/TP-T M68	HE-T M69	Blank M78
complete projectile LENGTH	1.066 kg 356 g	1.14 kg 435 g	960 g 250 g
complete projectile MUZZLE VELOCITY	304 mm 127 mm 1050 m/s	331 mm 150 mm 997 m/s	331 mm 144 mm n/a

30 mm Ammunition for 2A42

Yugoslavia has started to manufacture 30 mm ammunition for the 2A42 cannon installed in the former Soviet BMP-2 infantry combat vehicle.

Туре	HEI and HE	HEI-T	AP and AP-T	HE-T	TP-T	TP
DESIGNATION WEIGHT	M90	M90	M90	M90	M90	M90
complete round	833 g	826 g	853 g	826 g	826 g	833 g
projectile LENGTH	389 g	382 g	400 g	382 g	382 g	389 g
complete round	292 mm	292 mm	292 mm	292 mm	292 mm	292 mm
projectile	150 mm	150 mm	148 mm	150 mm	150 mm	150 mm
MUZZLE VELOCITY	960 m/s	960 m/s	970 m/s	960 m/s	960 m/s	960 m/s

37 mm Ammunition

This ammunition is for the former Soviet 37 mm M1939 towed anti-aircraft gun.

TYPE	AP-T and API-T	TP-T, TP HE, HE-T HEI and HEI-T
WEIGHT		
complete round	1500 g	1480 g
projectile	760 g	732 g
LENGTH		
complete round	382 mm	382 mm
projectile	172 mm	172 mm
MUZZLE VELOCITY	866 m/s	866 m/s

Bofors 40 mm L/70 Ammunition

The following types of ammunition for the Bofors 40 mm L/70 anti-aircraft gun are produced, in addition there is also a blank round.

Type WEIGHT	AP-T	HE-T	PFHE	HE	TP, TP-T
complete projectile LENGTH	2500 g 930 g	2500 g 960 g	2500 g 995 g	2500 g 960 g	2500 g 960 g
complete projectile	497 mm 188 mm	535 mm 206 mm	534.5 mm 225 mm	535 mm 206 mm	535 mm 206 mm
MUZZLE VELOCITY TRACER	1025 m/s	1005 m/s	1025 m/s	1005 m/s	1005 m/s
BURN TIME	3 s	3.5 s	none	none	none, 3.5 s

57 mm Ammunition

An HE-T round is produced for use with the 57 mm S-60 towed anti-aircraft gun and the S-68 gun mounted on the self-propelled ZSU-57-2.

HE-T
M66
6.36 kg
2.85 kg
536 mm
258 mm
1000 m/s
10 s
13-17 s

Bofors 40 mm L/60 Ammunition

The following types of ammunition are produced for the Bofors 40 mm $\mbox{L/}60$ anti-aircraft gun.

Туре	HEI-T	AP-T	HE-T	TP-T
WEIGHT complete	2100 g	2100 g	2100 g	2100 g
projectile	900 g	n/avail	900 g	900 g
LENGTH				7.5=
complete	447 mm	447 mm	447 mm	447 mm
projectile	199 mm	156.1 mm	193 mm	193 mm
MUZZLE VELOCITY	880 m/s	880 m/s	880 m/s	880 m/s
TRACER BURN TIME	7.8 s	5 s	5 s	5 s

76 mm Tank Gun Ammunition

For use in the 76 mm gun M2A1 installed in the M18 self-propelled tank destroyer and the Sherman tank (76 mm), both of which were developed during the Second World War, Yugoslavia produces the M42A1 HE round and details of this follow:

Designation	M42A1
WEIGHT (complete)	10.24 kg
LENGTH (complete)	820 mm
CARTRIDGE	brass
MUZZLE VELOCITY	823 m/s
PROPELLING CHARGE	NC powder
MAX RANGE	13 125 m

76 mm Ammunition for M48B1 Gun

Three types of ammunition are produced for the 76 mm M48B1 mountain gun designed and produced in Yugoslavia.

Туре	HE	HE	Smoke
DESIGNATION	M55	M70	M60
WEIGHT (complete)	9.00 kg	8.20 kg	9.00 kg
LENGTH (complete)	640 mm	642 mm	640 mm
CARTRIDGE CASE	brass	brass	brass
MUZZLE VELOCITY	398 m/s	398 m/s	398 m/s
PROPELLING CHARGE	NGB powder for all rounds		
MAX RANGE	8750 m	8750 m	8750 m

Ammunition for 76 mm Gun M42 and D-56T

For use in the 76 mm gun D-56T installed in the former Soviet PT-76 light amphibious tank, Yugoslavia manufactures the OF-350 fixed round which is based on a Soviet design.

Type	HE
DESIGNATION	OF-350
WEIGHT (complete)	9.00 kg
LENGTH (complete)	650 mm
CARTRIDGE CASE	brass
MUZZLE VELOCITY	680 m/s
PROPELLING CHARGE	NC powde
MAX RANGE	13 750 m

90 mm Ammunition for 90 mm Guns

This ammunition is used in the 90 mm gun installed in a number of systems developed in the United States during the Second World War including the M36 tank destroyer and the 90 mm M117 and M118 anti-aircraft guns.

Type	HE
DESIGNATION	M71
WEIGHT (complete)	19.10 kg
LENGTH (complete)	951 mm
CARTRIDGE CASE	brass
MUZZLE VELOCITY	823 m/s
PROPELLING POWDER	NC powder
MAX RANGE	17 887 m

Ammunition for 90 mm Tank Guns

Yugoslavia manufactures a 90 mm HEAT-T round that can be fired from the 90 mm armed M36 tank destroyer and M47 tanks.

Type	HEAT-T
DESIGNATION	M74
WEIGHT (complete)	17.00 kg
LENGTH (complete)	998 mm
CARTRIDGE CASE	brass
MUZZLE VELOCITY	900 m/s
PROPELLING CHARGE	NC powder
MAX RANGE	1000 m

100 mm Ammunition for T-54/T-55 MBTs

The ammunition is fired by the T-54/T-55 series of MBT as well as the SU-100 assault gun.

Туре	HE	HE	AP-T	HEAT-T
DESIGNATION	M63P1	M63P1	M65	M69
WEIGHT (complete)	30.20 kg	27.10 kg	30.50 kg	26,00 kg
LENGTH (complete)	1095 mm	1095 mm	1020 mm	1094 mm
CARTRIDGE CASE	brass	brass	brass	brass
PROPELLING CHARGE	NGH	NC	NGH	NC
MUZZLE VELOCITY	900 m/s	600 m/s	900 m/s	900 m/s
RANGE	20 650 m	11 000 m	1500 m	3000 m

Note: In addition there are HE practice and Blank (M71) rounds.

The AP-T M65 has the following penetration characteristics:

Range	60° impact angle	90° impact angle
500 m	130 mm	160 mm
1000 m	120 mm	150 mm
1600 m	110 mm	135 mm

105 mm Ammunition for M56 Howitzer

The ammunition produced for use with the Yugoslav M56 howitzer appears to be based on the American M1 series of ammunition and the three types produced are HE, Smoke WP and HESH. Details are as follows:

HE Known as M1 the complete round weighs 19 kg and the projectile weighs 15 kg. The explosive filling weighs 2.2 kg. The fuze fitted can be set for graze or 0.05 second delay.







100 mm M65 AP-T round

Smoke WP M60 The complete round weighs 20 kg and the projectile 15.8 kg. Uses the same fuze as HE.

HESH-T Known as the M67 this projectile has a maximum range of 12 045 m although the normal combat range is 870 m. The 10 kg shell contains 2.2 kg of explosive. When used against armour plate 100 mm thick at an angle of 30° the shell can cause a 25 mm thick scab to be blown off the side opposite the shot. The scab fragments may be up to 5 kg in weight and travel at a velocity of 300 m/s.

The above projectiles are propelled by a seven-charge system plus a super charge. The following details refer to this ammunition in use with the 105 mm M56 howitzer.

Charge	Muzzle velocity	Range
1	201 m/s	3700 m
2	221 m/s	4200 m
3	244 m/s	5100 m
4	275 m/s	6200 m
5	321 m/s	7950 m
6	390 m/s	9800 m
7	491 m/s	11 600 m
Super charge	570 m/s	13 000 m

122 mm Ammunition for M38 Howitzer

The following ammunition is manufactured for the 122 mm towed howitzer M1938 (M-30):

Type	HE	HESH-T	HE
DESIGNATION	M55	M69	TF-462
WEIGHT (complete)	27.00 kg	22.00 kg	27.00 kg
LENGTH (complete)	763 mm	765 mm	785 mm
CARTRIDGE CASE	brass	brass	brass
PROPELLANT	NC	NC33	NC
MUZZLE VELOCITY	205/515 m/s	640 m/s	515 m/s
MAX RANGE	11 880 m	930 m	11 800 m

122 mm Ammunition for Howitzer D-30

The following types of ammunition are manufactured for the 122 mm D-30 towed howitzer and its Yugoslav equivalent, the D-30j:

Type	HE	HE
DESIGNATION	TF-462/M78	TF-462/M78
WEIGHT (projectile incl fuze)	21.54 kg	21.54 kg
LENGTH (projectile excl fuze)	497/504 mm	497/505 mm
CARTRIDGE CASE	steel	steel
PROPELLING CHARGE	NC powder	NC powder
MUZZLE VELOCITY	565 m/s	690 m/s
RANGE	12 840 m	15 300 m

122 mm Ammunition for Corps Gun M1931/37 (A-19)

Yugoslavia manufactures the following ammunition for the former Soviet 122 mm towed Corps Gun M1931/37 (A-19):

164 AMMUNITION / Yugoslavia (Serbia/Montenegro)

Type	HE	HESH-T
DESIGNATION	M59	M69
WEIGHT (projectile)	25.01 kg	16.49 kg
LENGTH (projectile excl fuze)	498 mm	603 mm
CARTRIDGE CASE	brass	brass
PROPELLING CHARGE	NC	NC 33
MUZZLE VELOCITY	570/800 m/s	700 m/s
MAX RANGE	20 200 m	1000 m

130 mm Ammunition for M-46

The following types of ammunition are manufactured for the former Soviet 130 mm towed M-46 field gun:

Туре	HE reduced charge	HE variable charge
DESIGNATION	M79	M79
WEIGHT (projectile)	31.598 kg	31.598 kg
LENGTH (projectile excl fuze)	557 mm	557 mm
CARTRIDGE CASE	brass	brass
PROPELLING CHARGE	NC powder	NGH powder
MUZZLE VELOCITY	705 m/s	930 m/s
MAX RANGE	19 130 m	27 490 m

125 mm Ammunition for D-81TM (2A46) Tank Gun

For some years Yugoslavia has been manufacturing a modified version of the T-72 MBT under licence under the designation of the M-84. Yugoslavia is also manufacturing ammunition for the 125 mm D-81TM (2A46) gun including the fin-stabilised HE-FRAG round called the M86.

SPECIFICATIONS

OI LON IOATIONS	
DESIGNATION	M86
MUZZLE VELOCITY	850 m/s
MAX RANGE	12 200 m
WEIGHT (fuze)	435 g
LENGTH (fuze)	105 mm
PROJECTILE BODY	steel A1
WEIGHT (projectile body)	19.417 kg
LENGTH (projectile body)	615 mm
PROJECTILE CHARGE	Trotyl
WEIGHT OF CHARGE	3.148 kg
CARTRIDGE CASE	steel
WEIGHT (cartridge case)	885 g
LENGTH (cartridge case)	138 mm
PROPELLING CHARGE	NC-16, NC-44
WEIGHT (propelling charge)	5.355 kg
GUN PRIMER	steel
WEIGHT (gun primer)	70 g
LENGTH (gun primer)	25 mm



152 mm Ammunition for M84 Gun-Howitzer

The following ammunition is manufactured for the Yugoslav-produced 152 mm M84 towed gun-howitzer which will also fire ammunition used with the former Soviet 152 mm D-20 gun-howitzer.

HE has a muzzle safety of more than 10 m with the HE content weighing a total of 7.677 kg on a 50 per cent RDX basis. The cartridge case weighs 10.56 kg and is 820 mm long. The two main propellant charges are:

- (1) full, variable and two increment charges (full and first)
- (2) reduced, variable with five increments (second to sixth). Additional elements are de-copperising alloy, flash inhibitor and cover.

TYPE LENGTH	HE/ICM	ILL	HE
(projectile) WEIGHT	842 mm	n/avail	n/avail
(projectile) FUZE	43.6 kg electronic time	43.5 kg UTE, M87	43.56 kg impact, super-quick, time delay and inertia
MUZZLE VELOCITY RANGE PROPELLING CHARGE	810 m/s 22 500 m NGH-275	900 m/s 25 500 m M84	810 m/s 24 400 m M84

Notes: HE/ICM contains 63 KB-2 submunitions each of which has a calibre of 40 mm and contains 35 g of FH-5 explosive.

Illuminating projectile falls to the ground at 5 m/s and produces 1.3 million candelas for a period of 60 seconds.

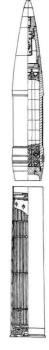
152 mm Ammunition for Gun-Howitzer D-20

Yugoslavia manufactures two types of ammunition for the 152 mm towed gun-howitzer D-20:

Туре	HE full variable charge	HE reduced variable charge
DESIGNATION	OF-540	OF-540
WEIGHT (projectile)	42.925 kg	42.925 kg
LENGTH (projectile incl fuze)	751 mm	751 mm
CARTRIDGE CASE	brass	brass
PROPELLING CHARGE	NGH powder	NC powder
MUZZLE VELOCITY	655 m/s	282-511 m/s
MAX RANGE	17 400 m	13 400 m

155 mm Ammunition for Converted Gun 155/45 mm M46/84

The converted Gun 155/45 mm M46/84 is a former Soviet 130 mm towed M-46 field gun modified with a new 155 mm calibre ordnance and in addition to firing the US M107 projectile it can fire Yugoslav manufactured



ERFB and ERFB-BB ammunition with welded nubs. Lethality is more than double that of standard HE projectiles. Dispersion at maximum range is not more than 0.5 per cent in range and 1.5 mils in deflection or an average of 0.42 per cent and 0.84 mils.

The converted gun ammunition set consists of the following: long brass cartridge case filled with M11 propellant charge and ERFB-BB projectile

long brass cartridge case filled with M11 propellant charge and ERFB projectile

short brass cartridge case filled with propellant charge M2 (zone 8 and 9) and ERFB projectile

short brass cartridge case filled with propellant charge M4A2 (zone 3 to 7) and ERFB projectile

short brass cartridge case filled with propellant charge M2 (zone 8) and M107 projectile

short brass cartridge case filled with propellant charge M4A2 (zone 3 to 7) and M107 projectile.

TYPE	ERFB	ERFB-BB
LENGTH	938 mm	950 mm
WEIGHT		
projectile	45.5 kg	47.5 kg
HE content	8.6 kg	8.6 kg
MAX RANGE	30 000 m	39 000 m

155 mm for M65 Howitzer

Only one round is produced for the Yugoslav 155 mm towed M65 howitzer, which is a close copy of the American M114 howitzer. The projectile is the American M107 produced in Yugoslavia and weighing 43 kg. The propelling charges used are the Charge M3 and M4A1. The maximum muzzle velocity when used with the M65 howitzer is 564 m/s with a maximum range of 14 900 m at 45° of elevation.

Contractor: Federal Directorate of Supply and Procurement (SDPR), PO Box 308, 9 Nemanjina Street, Belgrade, Yugoslavia (Serbia/Montenegro). Telephone: (011) 621 522 Telex: 11360/11541 Fax: (011) 635 702

Armoured Fighting Vehicle Protection Armour Systems

COMMONWEALTH OF INDEPENDENT STATES

Commonwealth of Independent States Explosive Reactive Armour

Development/Description

Since the early 1980s the Soviet Union, now the CIS, has been fitting Explosive Reactive Armour (ERA) packages onto its MBTs to increase their battlefield survivability against ATGWs that rely on their HEAT warheads to achieve armour penetration.

From 1984 T-64/T-80 MBTs deployed in the then Group of Soviet Forces Germany (now renamed Western Group of Forces) started to receive explosive reactive armour packages. More recently T-72 and some T-55s (such as those used by the Naval Infantry) have also been fitted with explosive reactive armour packages.

The basic principles of explosive reactive armour are given in the entry for the Israeli Blazer system in this section. Although some reports have stated that the former USSR copied the Blazer system following the capture of a number of Israeli tanks by the Syrian Army in the 1982 invasion of the Lebanon, it is now known that by then it was already aware of ERA technology.

There are two types of ERA blocks; the first is the standard shoe box type which has overall dimensions of approximately 25.5×13.5 cm; the second is a wedge type block. Both have an arrow indicating how they should be installed to provide the maximum degree of protection.

The standard ERA block has an ERA element (for example, two plates of steel separated by explosive) which can be positioned in one of two positions for maximum protection. The wedge type has a fixed ERA element.

Each panel measures about 250 \times 150 \times 70 mm and has four bolt holes, one at each corner, to attach one brick to each corner. Located centrally on the edge of each brick is a pair of mounting pins enabling it to be attached to the tank's main armour.

The reactive panels are placed at varying distances away from the basic armour of the tank. The configuration of the panels differs between T-64B to the T-80. While the configuration of the hull glacis panels is identical, there are significant differences on those attached to the turret and hull sides.

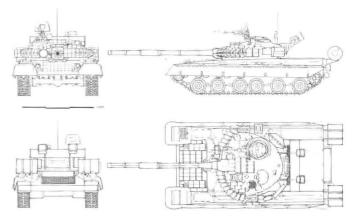
Both the T-64 and T-80 have hulls and turrets of advanced armour construction. The glacis plate of these, for example, is 200 mm thick at an angle of 22° to the horizontal and consists of two layers of steel, a layer of glass fibre, a layer of steel and finally a lead-impregnated plastic foam liner. The nose of the tank is similar but does not have the glass fibre or third layer of steel. When fitted with explosive reactive armour these tanks are invulnerable to current NATO anti-tank weapons, both kinetic energy and chemical energy, over their frontal arc.

The latest upgraded version of the T-80 MBT, called the T-80U by the CIS and SMT M1989 by NATO, has a new and different armour package. This includes a new type of explosive reactive armour box, armoured side skirts complete with lifting handles covering the upper sides of the hull and suspension and what appears to be a rubber or metal flap which is at an angle of 45°. The latter covers the gap between the turret front and the top of the hull and may well be a fixture to deflect top attack weapons using bomblets or other types of submunitions.

More recently the former Soviet Army has deployed ERA on some of its T-55 units which have already been upgraded in a number of other areas



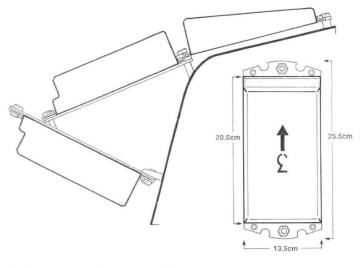
Close-up of the T-80U showing new armour package on turret and front skirts. Note also the flap between the turret and the hull



Four-view drawing of T-80 MBT fitted with explosive reactive armour array (Steven Zaloga)



Close-up of T-72 turret roof fitted with blocks of explosive reactive armour



Detailed drawing of the standard ERA box showing dimensions (right) and typical installation of two standard and one wedge type ERA boxes (left) (Steven Zaloga)

including the installation of a laser rangefinder. These have been identified to be in service with Naval Infantry units. Tanks with explosive reactive armour normally have a V in their designation, for example T-64BV, T-64BV1K, T-55MV and T-55MVK, however, the new T-80 is known as the T-80 I

In 1990, a T-72 appeared with a new explosive reactive armour array

which is believed to provide protection against both HEAT and KE attack. This version of the T-72 is referred to as the T-72 SMT1990 by NATO.

Status: In service with various armies of the CIS.

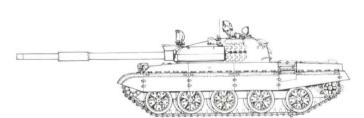
Manufacturer: State factories

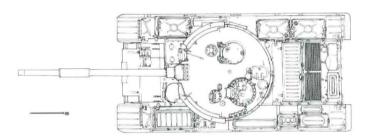
CIS Passive Armour

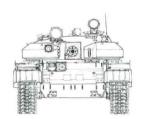
Development/Description

In the early 1980s the former Soviet Union began to fit a number of its T-62 MBTs with additional armour protection. This included lateral production for the fuel tanks running along each side of the hull top, additional armour protection for the glacis plate and a horseshoe armour array that runs from either side of the 115 mm smooth-bore gun halfway around the turret. This armour is of passive type with a gap between the armour array and the actual turret. The additional armour provides increased protection, especially against HEAT attack. Track skirts have also been fitted to the T-62. Although it is not believed these are armoured they do provide some degree of protection against HEAT attack and also help keep dust down when moving across country.

With these armour modifications T-62s have been observed in Afghanistan and similar modifications have been carried out on some T-54/T-55s in the









T-62 fitted with additional armour protection but without laser rangefinder over 115 mm gun (Steven Zaloga)

former Warsaw Pact. In the case of the T-54/T-55 this forms a part of a major improvement programme. These upgraded T-55s are called the T-55AMB2. It is known that the armour array on these T-55AMB2 is steel with an additional filling of other materials.

Status: In service with various armies of the CIS.

Manufacturer: State factories.



T-62 with additional armour protection and laser rangefinder over 115 mm gun during withdrawal of some Soviet forces from Afghanistan (Soviet Military Power 1987)



The T-55AMB2 has many improvements including a new fire-control system and additional armour protection for hull and turret (Michael Jerchel)

EGYPT

Kader M113A2 Add-on Armour Kit

Development/Description

The Egyptian Army has some 1000 members of the M113A2 family of aluminium armoured vehicles and to improve their battlefield survivability the Kader Factory for Developed Industries has developed an add-on armour package which was first shown in late 1984.

The package consists of panels of steel armour which are fixed to the front and sides of the hull, each panel weighs 25 kg. Between the armour plate and the original aluminium armour of the M113 vehicle is a layer of foam. The total weight of the add-on armour package is about 950 kg so the

amphibious characteristics of the vehicle are retained. Some of the steel armour panels are interchangeable and no special tools are required for their removal.

The Kader add-on armour panels provide ballistic protection against 23 mm projectiles fired from a range of 200 m through a 70° arc over the front of the vehicle, against 14.5 mm AP projectiles fired from a range of 100 m through a 90° arc over the front of the vehicle and against $7.62 \text{ mm} \times 54 \text{ mm}$ small arms fired from a range of 30 m through a full 360° .

Although originally designed for the basic M113 series of APC, the addon armour kit is also applicable to specialised versions of the vehicle including 120 mm mortar carrier, air-defence and anti-tank. Status: Development complete. Ready for production.

Manufacturer: Kader Factory for Developed Industries, Orouba Street,

Heliopolis, POB 287, Arab Republic of Egypt.

Telephone: 611142; 604324 Telex: 92136, 22651 KADFA UN

Fax: 2608718



Egyptian Army M113A2 APC with additional armour protection (Christopher F Foss)

FRANCE

Giat Industries Armour Systems

Development

Giat Industries is the sole producer of MBTs in France and in recent years has developed and produced a wide range of tracked and wheeled vehicles for the home and export markets.

These include the AMX-30 MBT, AMX-30 B2 MBT (still in production), AMX-32 (prototypes only), AMX-40 (prototypes only), AMX-30 Roland SAM, AMX-30 D ARV, AMX-30 AVLB. AMX-30 DCA twin 30 mm SPAAG (export only), AMX-30 Pluton SSM, AMX-30 Combat Engineer Tractor (currently in production), Shahine SAM system (export only), GCT 155 mm self-propelled howitzer (currently in production), AMX-10 P family of tracked infantry vehicles and the AMX-10 RC (6×6) 105 mm armoured vehicle. It is also now involved in European production of the Multiple Launch Rocket system and develops and produces armour systems for the Leclerc MBT.

Up until the 1960s Giat Industries worked mainly in steel armour but then also became involved in building ARVs of aluminium armour (AMX-10 P and AMX-10 RC).

Studies in composite materials commenced in 1966 and covered a wide range of materials used either individually or in combinations to produce armour of better quality and lighter weight.

The above developments led in 1970 to the introduction of CERALU armour, a weldable structure consisting of a ceramic and aluminium base offering a 50 per cent weight saving over steel. This concept was the precursor to all other French composite armour work, resulting in the marketing of an aluminium based ballistic ceramic armour still used as a reference. One current application of this material is in helicopter seats.

In 1972 projects using ceramic, laminates and resin bases for use on French Army helicopters were carried out and this material has formed the basis for all other armours of this type produced in France to date.

At the same time, with encouragement from Giat Industries, Creusot-Loire finalised the development of its original extra hard armour, a high performance material consisting of two or three layers of differing hardness and offering the additional advantage of weldability.

Studies that previously had examined metal processing and protection against small and medium calibre armour piercing projectiles were extended to cover the fields of anti-tank penetrators and shaped projectiles. Research

was also undertaken into all aspects of attack on the widest possible ranges of materials. Original concepts were developed in the fields of passive and explosive reactive armour.

Currently in production for the French Army is the Giat Industries Leclerc MBT which has many advanced features and also incorporates advanced armour in its design, giving a high degree of battlefield survivability.

Giat Industries and its Mécanique Cresuto-Loire subsidiary, are now offering a range of add-on armour packages for a variety of tracked and wheeled armoured vehicles of which two, one for the TS 90 90 mm turret and the other for the M113 series of APC's, are described. Also developed is explosive reactive armour for MBTs such as the AMX-30. This consists of small packs which are attached to the MBT but which will not be exploded by small arms fire and artillery splinters or by the adjacent fratricide pack.

AMX 30 reactive armour kit

During the Euro Satory 92 exhibition, Giat Industries presented the AMX-30 reactive add-on armour packs for the first time to the general public. All the packs are identical and serve, on the AMX-30, to neutralise the effect of major aggressions. They are insensitive to small and medium calibre ammunition and to shell splinters.

TS 90 turret armour upgrade

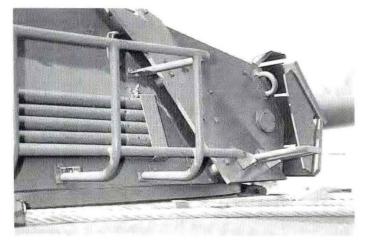
In 1988 Giat Industries announced that it was offering an armour upgrade package for its 90 mm armed TS 90 turret which is fully described in the *Turrets and Cupolas* section.

The TS 90 turret, like most other turrets of this type, provides the commander and gunner with protection from small arms and some shell splinters only. Recent combat experience has shown that many turrets of this type can be penetrated by small arms fire at close range, especially when the vehicles are being used in an urban situation.

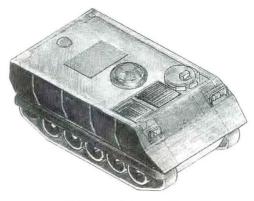
Giat Industries is now offering an up-armouring package for the TS 90 turret that can stop 12.7 mm armour piercing rounds fired at a range of 100 m from any angle, up to 20 mm OPT projectiles fired over the frontal arc and the 14.5 mm AP projectile from any angle on the turret side.

Giat Industries has now developed two types of add-on armour for the TS 90 turret, one with a high strength steel base and the other employing a ceramic tile base on a metal support. Each panel is light enough to be replaced by one man in the field.

As the Giat Industries armour packages are designed to fit on the mantlet, sides and rear, the original silhouette has not changed. The average weight of the kit is about 300 kg so mobility is hardly effected.



MARS 15 light tank version with Giat Industries TS 90 turret which has addon frontal armour (Christopher F Foss)



Artist's impression of M113 showing Giat Industries add-on armour kit which is of modular construction to facilitate ease of removal

AMX-10 RC armour package

In 1990, Giat Industries developed and produced for the French Army the AMX-10 RC, an add-on armour package to increase the ballistic protection of the turret and the chassis. This participated in the Desert Storm operation. It is estimated that the majority of the AMX-10 RC should in future be provided with light performance armour package.

Status: Production as required.

Manufacturer: Giat Industries, 13, route de la Minière, Satory 78034,

Verasilles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

CERACHOC Ceramic Armour Systems

Development/Description

CERACHOC is a subsidiary of Ceraver (qv) and Vibrachoc and produces a wide range of ceramics for both civil and military applications.

The company has recently developed an add-on armour kit for the M113 series of armoured personnel carriers, which provides protection against 20 mm armour-piercing rounds over the frontal arc and 12.7 mm protection over the hull sides

CERACHOC has been awarded a study contract with an overseas client for an add-on ceramic armour kit that will provide protection against penetration from former Soviet 14.5 mm KPV rounds.

The ceramic armour is available in various shapes and sizes and can be used either in or outside of the vehicle, with the latter being the most common due to space problems within the actual vehicle.

Versions of CERACHOC ceramic armour can be provided that give complete protection against penetration not only from small arms fire but also 20 mm APDS, 105 mm APDS and RPG-7 anti-tank rockets with their **HEAT** warheads

The composition of the armour depends on the particular application. It can be made of hard materials (ceramic or steel) or of soft materials based on aramid and shock-absorbing elastomer or of a combination of both hard and soft materials. Maximum plate dimensions are 1 x 1.2 m.

Status: Production as required.

Manufacturer: CERACHOC, Parc d'activities de l'Eglantier-Lisses,

CE 2804 Lisses, F-91028 Evry Cedex, France.

Telephone: (1) 64 97 70 70 Telex: 600672 F Fax: (1) 64 97 50 28

SCT Ceramic Armour

Development/Description

This company manufacturers a wide range of ceramic armour tiles in various shapes and sizes which can be mounted on the front of armour composites to absorb energy and break the core of armour-piercing projectiles. The degree of protection offered by the SCT ceramic armour depends on the dimensions, form and grade of ceramic as well as the mode of incorporation into the actual structure. Ceramics offer a significant decrease in weight compared to conventional steel.

At least two types of ceramic armour are offered. The aluminium oxide based ceramic armour uses five different grades of alumina (92 to 99.9 per cent) while the non-oxide based ceramic armour uses silicon carbide.

Status: Production as required.

Manufacturer: Société Des Ceramiques Techniques (SCT), BP 1, F-65460 Bazet, France

Telephone: (1) 62 37 92 91 Telex: 520194 F Fax: (1) 62 37 80 06

SNPE Insensitive Material for Explosive Reactive Armour

Development

From 1986, extensive co-operation has taken place between SNPE of France and Kaman of the United States of America to promote a completely new Explosive Reactive Armour (ERA).

SNPE is a specialist in high explosive and propellants and has developed a family of insensitive materials. Kaman has the design and test capability to ensure maximum protection for a given amount of energetic material.

The new ERA is based on the very low sensitivity of the cast Plastic Bonded Explosives (cast PBX) developed by SNPE as well as on the specific internal architecture of the cassettes.

The main advantages cast PBX provide are:

- (1) Local reaction to intense shock of a shaped charge jet.
- (2) No mass detonation and consequently no sympathetic detonation.
- (3) High insensitivity characteristics which give the cassettes ease of handling and storage
- (4) The energy released by the energetic material is self-adjusted to the jet intensity.
- (5) Life duration and operating conditions matching the armoured vehicle specifications.

The add-on protection comprises sandwiches including energetic material sheet confined between metal plates. These sandwiches are mounted in metal boxes called cassettes that are attached to the hull and turret of the vehicle. When a cassette is hit by an anti-tank round, the advanced explosive reactive armour reacts only locally and dislocates the jet before it damages the vehicle's armour. The local reaction only moves part of the metal plates which is sufficient to disrupt the shaped charged jet, but as the energetic material reacts only partially the main part of the sandwich remains. This results in very low energy release but a high disruption efficiency. Small calibre projectiles up to 30 mm, artillery or mortar round fragments have no effect on the cassettes.

These advanced explosive reactive armour cassettes are specifically

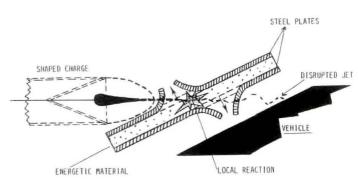
designed to defeat shaped charge threats from the smallest calibres up to munitions with 1000 mm penetration capability.

Status: As a result of this co-operation, SNPE and Kaman were awarded a contract by the US Army for the evaluation and delivery of several hundred cassettes of advanced explosive reactive armour for the Bradley IFV. In March 1990, the two companies formed a joint venture company called AEMC (Advanced Energetic Material Corporation of America), who will be in charge of the design, development, production and marketing of this ERA.

An explosive reactive armour package for the M60 series MBT has been developed and was under evaluation in several countries in early 1992.

In 1992, in competition with two other undisclosed countries, SNPE demonstrated its ERA packages in Taiwan.

Manufacturer: SNPE - Société Nationale des Poudres et Explosifs, 12 qua Henri-IV, F-75181 Paris, France.
Telephone: (33) (1) 48 04 66 66 Telex: 240 881 F Fax: (33) (1) 48 04 66 14



Sequence of operation of SNPE ERA which incorporates insensitive materials

Mécanique Creusot-Loire Add-on Armour Kits

Development/Description

Mécanique Creusot-Loire has developed a range of add-on armour packages that is suitable not only for its own AMX-13 light tanks but also for the more widely deployed FMC M113 series APC.

The add-on armour package for the AMX-13 light tank weighs under 650 kg with no single unit weighing over 50 kg, so enabling it to be installed or removed by the crew using onboard tools.

In the case of the AMX-13 light tank, the add-on armour package is installed on the turret front and sides and on the nose and glacis plate. When fitted it provides protection against penetration from 20 mm armour-piercing projectiles fired from a range of 100 m over a frontal arc of about 180°.

The next level of protection kit weighs a total of 750 kg and provides protection against 12.7 mm AP and 14.5 mm API projectiles fired from a range of 100 m over 360° and protection against 20 mm and 23 mm AP rounds fired from a range of 200 m over 90° arc.

Like the add-on armour package for the AMX-13, the one for the M113 can be installed or removed by the crew using onboard tools, although some panels, for example those around the headlamps, cannot be removed easily.

All access panels, for example those in the front that allow access to the engine for maintenance, can still be used.

When fitted with this kit the amphibious characteristics of the M113 APC are retained.

The AMX-13 and M113 package uses hardness steel or composite armour.

SPECIFICATION Kit designation	NS Threat type	Range	Frontal protection angle	Kit weight
CLI-113-20	12.7 mm AP	100 m	360°	
	14.5 mm AP 20 mm & 23 mr	100 m	360°	
	AP	200 m	90°	750 kg

Status: Development complete. Production as required.

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13, route de la Minière, Satory 78034, Versailles Cedex, France. Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00



M113 APC fitted with Mecanique Creusot-Loire add-on armour kit



M113 series APC fitted with Mecanique Creusot-Loire add-on armour kit. This is a Swiss Army vehicle

Creusot-Loire Industrie Armour Plates

Development/Description

Creusof-Loire Industrie is a subsidiary of the Usinor-Sacilor Group and specialises in the production of heavy plates, forgings and castings of high quality.

In addition to producing armour plates, Creusot-Loire Industrie can cut shapes to order using oxygas, plasma and laser, ready for fitting or welding into vehicle components such as hulls. Laser cut steel plates can be used for robot welding while special grades are available for targets in addition to those listed.

SPECIFICATIONS DESIGNATION BRINELL HARDNESS	MARS 160 320	MARS 190 388	MARS 240 500	MARS 300 600	Dual Hardness 600 front 440 rear
THICKNESS	3 to	3 to	2.5 to	3 to	7 to
	203 mm	508 mm	51 mm	25 mm	102 mm
WIDTH	3.048 m	4.064 m	2.590 m	2.5 m	2.540 m
LENGTH	13.208 m	13.208 m	8.28 m	3.9 m	8 m

Notes

MARS 160

Typical applications include sentry boxes, observation posts, buildings and underground firing ranges.

MARS 190

This is used for the same applications as above plus tanks and other armoured vehicles. Its US equivalent is MIL-A-12560.

MARS 240

Same applications as MARS 160 and MARS 190 plus individual protection vests, shields and add-on armour kits. Its US equivalent is MIL-A-46100.

MARS 300

Armour, add-on armour, part of composite armour.

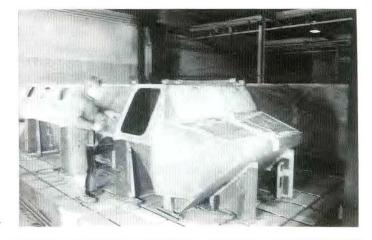
Dual Hardness

Same applications as MARS 240. Its US equivalent is MIL-A-46099.

Status: Production. Supplied to many manufacturers for various AFV programmes including AMX-13 family, AMX-30 family, Panhard armoured cars (including the VBL), Renault VAB and VBC 90 vehicles and Crotale SAM systems.

Manufacturer: Creusot-Loire Industrie, Immeuble IIe de France, Cedex 33, F-92070 Paris La Défense, France.

Telephone: (33) (1) 49 00 58 00 Telex: CCLAR 620 132 F Fax: (33) (1)



The hull of this VAB APC is made from Creusot-Loire Industrie steel armour

GERMANY

Blohm + Voss Armour Systems

Development/Description

Blohm + Voss has been engaged in the design, development and production of a wide range of armoured hulls and turrets for both tracked and wheeled armoured vehicles since the 1950s. In the case of the former, the welded and machined turret is normally sent to another contractor for final fitting out before it is installed on the vehicle, while in the case of the hulls they leave the factory ready for the installation of subassemblies such as power pack and suspension.

Turrets and hulls built by Blohm + Voss in recent years include:

Turrets for Hotchkiss and Hispano-Suiza vehicles with production being undertaken between 1959 and 1963; 2000 turrets built.

Turrets for the Marder 1 IFV with production being undertaken between 1970 and 1977; 2000 turrets built.

Turrets (welded) for Leopard 1 MBT from 1972 to 1978; over 340 built. Hulls for SW1 (4 × 4) APC with production being undertaken between 1960 and 1962; 220 hulls built.

Turrets for Gepard anti-aircraft tank from 1975 to 1979; 287 turrets built. Turrets for 408 Luchs (8 × 8) reconnaissance vehicles between 1975 and 1977

Turrets for Roland air defence system from 1979 to 1989; 344 turrets built. Hulls for Leopard 1 MBT with production being undertaken between 1965 and 1975 with over 2000 hulls delivered.

Hulls and turrets for prototypes of the MBT 70 project between 1967 and 1969

Hulls for Gepard anti-aircraft tank: 570 built between 1975 and 1980 Parts for the 110 mm LARS with production being undertaken between 1968 and 1970.

Hulls and turrets for Leopard 2 MBT from 1979.

Up-armouring Kits

Blohm + Voss, in co-operation with the Federal Office for Military Engineering and Procurement, developed an up-armouring kit for the Leopard 1A3 MBT which, when fitted, provides the same degree of protection as the later Leopard 1A4 with its welded turret. The total weight of this armour is 700 kg. Similar kits have been developed for other vehicles including the AMX-30, M48, M113 and the Jagdpanzer Rocket tank destroyer. In addition to delivering Leopard 1 up-armouring packages to the German Army they have also been delivered to the Netherlands.

Blohm + Voss Liner Technology

The company has developed liner technology for installation on the interior surface of armoured vehicles which, when fitted, offer the following advantages:

- (1) protection against the effect of shaped charges
- (2) reduction in noise level

Ammunition type

- (3) reduction in infra-red signature
- (4) improvement in the nuclear radiation protection factor.

T-54/T-55 Armour Upgrade

In 1992 Blohm + Voss announced that it had developed, as a private venture, a new passive armour system for installation on the former Soviet T-54/T-55 MBT

This armour package is of modular construction and mounted on the turret, hull sides and glacis plate with special shock absorbing mounting brackets

A T-54/T-55 fitted with this armour package has the following protection level:

Flank angles

Up to 120 mm DM13 APFSDS	10°
TOW 1 ATGW	10°
Sagger ATGW	17°
RPG-7 anti-tank rocket	all round
SPECIFICATIONS	
Turret	
RIGHT MODULE	690 kg
LEFT MODULE	690 kg
BUSTLE MODULE	885 kg
Hull	
FRONT MODULE	945 kg
TRACK SKIRTS	1990 kg
TOTAL WEIGHT	2935 kg

M48 and Leopard 1A4 Armour Upgrade

This modular armour upgrade is of a similar type to the above but is only installed on the frontal 180° arc of the turret and provides the following protection level:

Ammunition type	Range	Flank angle Leopard 1A4/M48
Up to 125 mm APDS	1500 m	20°/15°
30 mm cannon	800 m	90°/90°
Sagger ATGW	1500 m	20°/20°
RPG-7 anti-tank rocket	100 m	45°/90°



Leopard 1 MBT with Blohm + Voss developed add-on armour to provide increased protection



Upgraded 105 mm armed M48 MBT fitted with second-generation armour package from Blohm + Voss

172 ARMOUR SYSTEMS / Germany-Iraq

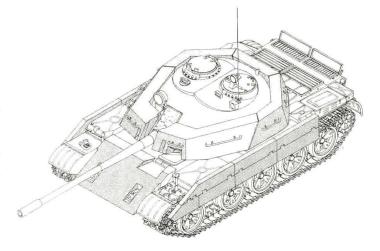
SPECIFICATIONS		
Vehicle	Leopard 1A4	M48
RIGHT TURRET MODULE	1460 kg	1978 kg
LEFT TURRET MODULE	1800 kg	1993 kg
FRONT TURRET MODULE	1295 kg	1150 kg
MOUNTING ELEMENTS	220 kg	180 kg
TOTAL WEIGHT	4775 kg	5300 kg

Status: Production as required. In service with German Army and other countries

Manufacturer: Blohm + Voss, Postfach 10 07 20, D-2000 Hamburg,

Telephone: (49-40) 31 191316 Telex: 2627 - 403806 - buhhms Fax: (49-

40) 315992



T-54/T-55 with additional armour on hull and turret

Thyssen Henschel M113 Supplementary Armour

Development/Description

As a private venture Thyssen Henschel has developed a supplementary armour kit for the M113 APC. Total weight of the kit is about 760 kg and when fitted on the M113 its amphibious characteristics are retained.

The kit provides protection to the front and sides of the M113 and consists of a special armour steel which has a thin layer of rubber either side. To the rear of this is a special plastic plate that backs onto the hull

According to Thyssen Henschel, this armour package provides the following levels of protection:

FRONT AND SIDE 7.62 mm SmK at 30 m range FRONT 14.5 mm BS 41, HK at 100 m range

20 mm DM43, HK at 200 m range SIDE, TOP AND BOTTOM Side angle 45°

14.5 mm BS41. HK at 100 m

Side angle 35°

20 mm DM43, HK at 200 m

Status: Development complete. Ready for production.



As shown in this rear view no additional protection is provided to rear of M113 when fitted with Thyssen Henschel supplementary armour kit

Manufacturer: Thyssen Henschel, Postfach 102969, D-3500 Kassel, Germany

Telephone: (0561) 8011 Telex: 099 750 Fax: (0561) 81 6733

Diehl Remscheid Armour Systems

Development/Description

In addition to the design and manufacture of tracks for armoured fighting vehicles, Diehl Remscheid have more recently moved into the area of armour systems.

This armour system comprises different types of basic materials depending on the specific application including ultra-light armour for wheeled vehicles, bullet-resistant vests and other military and non-military equipment. In 1992 the company supplied its armour to MOWAG of Switzerland for incorporation into a new vehicle

According to Diehl, the main advantages of their armour system can be summarised as follows:

(1) bullet-proof to DIN 52290, classification C5/M5

- (2) detonation pressure-resistant to DIN 52290, classification D3
- (3) same protection effect as concrete/armoured steel but at a substantially lower surface area/weight ratio
- (4) shallow installation depth
- (5) individual finish according to specific user requirements
- (6) can be retrofitted to vehicles.

The Diehl armour system comprises three layers, a specially developed outer ceramic layer, a bonding layer and a backing layer.

Status: Production as required.

Manufacturer: Diehl Remscheid GmbH & Co, Vieringhausen 118, PO Box 10 02 69, D-5630 Remscheid 1, Germany.

Telephone: (02191) 791-1/207, 218 Telex: 8/513800 die d Fax: (02191) 791-282

IRAQ

Iraqi AFV Armour Packages

Development/Description

During a defence equipment exhibition held in Baghdad in 1989, two AFVs of the Iraqi Army were shown fitted with additional armour protection that had been developed locally.

The first of these was a BMP-1 ICV fitted with an appliqué armour package weighing a total of 1250 kg. This appears to be similar in appearance to the Israeli Toga add-on armour but is believed to be a different design. It provides protection against 12.7 mm and 14.5 mm kinetic energy attack from a range of 200 m. The armour has only been added to the sides of the hull, including the rear troop compartment, with spaces being cut in the armour for the firing ports. The additional armour extends downward to cover the upper part of the BMP-1's suspension. There is no additional protection provided for the turret or glacis plate.

The T-series (conversions appear to use both the T-54/T-55 and the

Chinese Type 69 MBTs) MBT was fitted with boxes of multi-layer armour on the glacis plate, upper part of the front hull and suspension, turret front and sides and part of the turret rear. The armour package on the turret front and sides hinges upwards for access purposes. In addition the vehicle was fitted with new night vision equipment and a bank of four electrically operated smoke dischargers either side of the turret and attached to the armour package. When fitted with the additional armour package the power-to-weight ratio decreases to 14.7 hp/t compared to 16 hp/t of the vehicle in its original form. This armour package is believed to have consisted of layers of steel and rubber.

Status: A number of T-series MBTs with additional armour protection were engaged during Operation Desert Storm early in 1991.

Manufacturer: Iraqi Government facilities.



T-series MBT of the Iraqi Army from rear showing additional armour on turret and forward part of hull (Christopher F Foss)



BMP-1 of the Iraqi Army with additional armour protection on sides of hull



Captured Iraqi MBT fitted with additional armour on its turret and hull for increased survivability (Christopher F Foss)

ISRAEL

Blazer Explosive Reactive Armour

Development

Israeli experience in the 1973 Middle East conflict showed that there was a requirement for increased protection of MBTs from anti-tank guided weapons such as the AT-3 Sagger and manportable anti-tank weapons such as the RPG-7, both of which have a HEAT warhead.

To meet this requirement the RAFAEL Armament Development Authority designed and developed the Blazer add-on explosive reactive armour. This was widely fitted to Israeli Army Centurion, M48A5, M60 and M60A1 tanks during the 1982 invasion of the Lebanon.

Blazer is jointly marketed by the RAFAEL Armament Development Authority and TAAS - Israel Industries Ltd.

Description

The Blazer explosive reactive armour is mounted on the outside of the MBT and consists of Modular Protective Elements (MPE) each of which contain one or more inserts filled with a specially formulated explosive compound which is sandwiched between two metal plates. The MPE is set at an oblique angle to the attack direction of the jet.

When the HEAT projectile reaches the MBT its high-speed jet initiates the explosive between the two plates and drives the plates aside. These moving plates perturb and eat the mass of the incoming jet which is then unable to achieve any significant penetration of the main tank armour

Extensive trials have shown that the Blazer explosive reactive armour is not activated by small arms fire, artillery or mortar shell fragments.

Blazer is custom designed to fit each specific type of tank and consists of MPEs of various configurations, determined by the thickness and obliquity of the tank's existing armour.

Blazer can be installed on any typical MBT and adds approximately 1000 kg to the total weight of the vehicle. It is fitted by means of threaded bolts previously welded to the tank's hull and turret. Each MPE has flat eye brackets which fit over the bolts and are affixed by a nut. Each MPE is individually numbered and placed on a corresponding numbered location on the hull and on the turret.

The installation of Blazer on an MBT requires no specially trained personnel and is not a time consuming process. The retrofitting of Blazer involves only the welding of bolts to the hull turret at the indicated places.

In the Israeli Army, the welded bolts were seen on Centurion, M48A5 and M60A1 MBTs for some years before their actual role became apparent in 1982



M60A1 MBT of Israeli Army fitted with Blazer explosive reactive armour to its hull and turret

According to TAAS - Israel Industries Ltd the Blazer add-on explosive reactive armour provides the following protection:

Turret sides

Complete arrest of the AT-3 Sagger ATGW at 30° (NATO 60°) incidence.

Front of hull

Complete arrest of RPG-7 at all angles of attack (0° incidence).

Over 70 per cent of the frontal arc of the hull, Blazer provides complete protection against the AT-3 Sagger ATGW at all angles of attack.

SPECIFICATIONS

Compatibility with MBT system: complete, this includes optics, fire-control, machine guns and escape hatches

Initiated by: shaped charge munitions

Not initiated by: small arms ammunition up to 23 mm API at all angles of attack from zero range. Artillery and mortar fragments from 2 m. Arc welding and autogen cutting

Sympathetic initiation: none

Military Specifications: passes all relevant tests of Mil Spec 810C

Status: In production. In service with the Israeli Army.

Manufacturers: TAAS – Israel Industries Ltd, Export Division, PO Box 1044, Ramat Hasharon 47100, Israel.

Telephone: (3) 5455370 Fax: (3) 6959906

RAFAEL Armament Development Authority, PO Box 2082, Haifa 31021,

Israel

Telephone: (4) 776965 Telex: 471568 VERED IS Fax: (4) 796457

RAFAEL Toga Add-on Passive Armour

Development

Toga add-on passive armour has been developed by RAFAEL Armament Development Authority to provide light armoured vehicles, for example the M113 series, with increased protection against light armour-piercing projectiles. It was installed on a number of the M113 series vehicles deployed in the 1982 invasion of the Lebanon by the Israeli Army.

Description

Toga consists of special thin, lightweight carbon steel sheets with small holes that are attached to a steel frame some distance from and parallel to the vehicle's hull. When a bullet hits the Toga armour it is deflected from its trajectory and becomes implanted in the armour, so that it does not reach the actual hull of the vehicle.

Toga provides protection against penetration from APDS rounds fired by automatic weapons up to 14.5 mm in calibre, for example the KPV 14.5 mm machine gun which is fitted to many former Soviet armoured vehicles including the BTR-60 (8 \times 8) APC and the BRDM-2 (4 \times 4) amphibious scout car.

In the case of the M113 the Toga armour is normally fitted to the hull front and sides with some of the space between the armour and hull sides being used for stowage of the troops' equipment. Access panels are provided in the glacis armour to allow access to the normal engine hatches for maintenance work.

In mid-1989, RAFAEL Armament Development Authority announced

that it had been selected as the sole winner of an open competition to deliver three complete, pre-production Enhanced Appliqué Armor Kits (EAAKs) for the US Marine Corps AAV7A1 vehicles.

This package will provide increased protection for the vehicles hull sides, including the upper sloping part, the roof and the three crew hatches.

Following trials with these EAAKs the US Marine Corps awarded the company a contract for the supply of 1137 EAAKs with final deliveries being made early in 1993.

Explosive Reactive Armour

Martin Marietta and RAFAEL as the main subcontractor are competing with FMC of the USA for an armour upgrade for the US Army's Bradley Infantry Fighting Vehicle.

The Martin Marietta/RAFAEL solution uses the latest reactive hybrid armour package which is installed on the hull and turret to defeat a variety of battlefield threats.

The latest Phase IIB tiles were loaded with a new flame-resistant explosive to meet a US Army requirement that tiles hit by small arms fires will not ignite and burn.

Status: In production. In service with the Israeli Army and US Marine Corps.

Manufacturer: RAFAEL Armament Development Authority, PO Box 2082, Haifa 31021, Israel.

Telephone: (4) 776965 Telex: 471568 VERED IS Fax: (4) 796457



M113 APC of Israeli Army fitted with RAFAEL Armament Development Authority Toga passive add-on armour system



US Marine Corps AAV7A1 vehicle fitted with the RAFAEL Armament Development Authority EAAK package to the hull sides and roof hatches

Urdan M113 Add-On Armour Kit

Development

Urdan Industries has the largest foundries in Israel and its Associated Steel Foundry (ASF), Hatzor and Vulcan Foundries produce a wide range of armoured steel castings. It is also a qualified manufacturer for the US Army of MIL-A-11356E ballistic steel.

The Urdan Foundries are supported by Urdan Machining plant which can machine items up to 15 tonnes and 4 m in diameter. The Urdan Armoured Steel Foundry was established in support of the Israeli Merkava MBT programme and today provides many of its key components including hull front, hull deck, gun shield, gun mount, turret basket, commander's hatch, track shoes, road wheels, idler wheels, hub sprockets, hub wheels, arm assemblies, arm housings, final drive housings and final drive carriers.



90°

The company has also developed an add-on armour kit for the M113 APC. This is available in two levels of protection to meet different threat levels.

According to Urdan the add-on armour kit is lightweight and sufficiently compact so as not to interfere with the vehicle's mobility. The replacement of single panels can be carried out by one soldier.

The kit is of modular construction allowing it to be mounted on the vehicle without special tools or equipment. When installed on the M113 it provides a significant increase in armour protection over the front, rear and sides of the vehicle.

SPECIFICATIONS

Level 1A KIT DESIGNATION THREAT TYPE

FRONTAL FAN PROTECTION ANGLE

RANGE

14.5 mm API 100 m

360

20 mm AP 200 m

90

UA-113-75

WEIGHT (kit) 800 kg Level 2

KIT DESIGNATION UA-113-85 THREAT TYPE 14.5 mm API

20 mm AP RANGE 0 m FRONTAL FAN PROTECTION

ANGLE 180°

WEIGHT (kit) 850 kg

Other armour

In addition to the M113 add-on armour kit and the armour it supplies to the Merkava MBT, Urdan Industries can also supply add-on armour systems for other APCs and IFVs, panels for light vehicles and trucks, spall liners and explosive reactive armour systems to provide increased protection against HEAT attack

Status: Series production.

Manufacturer: Urdan Industries Limited, Industrial Zone, Netanya 42378.

Telephone: (972) 53-338074 Telex: 341822 UASF-IL Fax: (972) 53-

610246

POLAND

Polish Explosive Reactive Armour

Development/Description

In late 1992, the Polish Military Institute of Armament Technology (WITU) stated that they had developed and tested two types of explosive reactive armour, ERAWA-1 and ERAWA-2.

Development of these has been completed and production can start on receipt of firm orders. The ERAWA-1 has a single layer of explosive armour blocks while the ERAWA-2 has two layers for increased battlefield survivability

The ERAWA system can be fitted to MBT's such as the T-72. A T-72 MBT fitted with ERAWA-1 blocks has its turret protected by 108 blocks and the hull by 118 blocks and each of the two side skirts by 84 blocks. This gives the vehicle a total of 384 blocks with the total area of the tank protected being about 9 m2. Compared with the ERA system developed in the former Soviet Union, the Polish ERA blocks are of a different shape and design. The former Soviet Union blocks are oblong whereas the new Polish blocks are more square in shape with a small attachment hole at each corner.

According to the WITU, the installation of the ERAWA-1/ERWA-2 armour package reduces the penetration capability of a shaped charged round by between 50 and 70 per cent, this depending on the incidence angle of the iet of the shaped charge on the armour block.

The Polish armour package is insensitive to 7.62 mm, 12.7 mm and 14.5 mm AP, API and HE small arms fire as well as fragments of cannon rounds with a calibre of between 20 and 30 mm.

Trials have shown that only the ERAWA block hit by a HEAT round will be initiated while the adjacent blocks are not initiated, although there is a possibility that they may be damaged or torn off.

The blocks and their associated attachments have been designed so that they can be placed very close to each other. On a flat surface it is claimed that up to 95 per cent of the surface can be protected while on convex surfaces, such as that of the MBT turret, between 80 and 90 per cent can

Although designed originally for installation on MBTs, the ERAWA packages can also be installed on other types of vehicle including infantry fighting vehicles as well as static pillboxes and other installations that may be attacked by weapons fitted with HEAT warheads.

In addition to being fitted with ERAWA packages, the T-72 was also fitted with a bank of six 81 mm smoke dischargers either side of the turret in an inverted L arrangement and, below these, were a further six unidentified sockets. Either side of the turret was a cylinder which is believed to be a laser warning device with additional laser warning devices being positioned on either side of the turret at the rear to give virtual 360 degree coverage.

Status: Development complete. Ready for production.

Manufacturer: Polish state factories.

This system was developed by: Military Institute of Armament Technology, ul St Wyszynskiego 7, 05-220 Zielonka, Poland.

Telephone: (48 2) 611 50 31 Telex: 817604 WITU PL Fax: (48 22) 10 30 37



Polish built T-72 MBT fitted with the Polish designed ERAWA-1 explosive reactive armour system on turret, hull and side skirts

SPAIN

SANTA BARBARA Explosive Reactive Armour

Development/Description

The SANTA BARBARA explosive reactive armour, usually referred to as the Sistema SBBR (SANTA BARBARA Blindaje Reactivo) has been developed by the company to improve the battlefield survivability of armoured fighting vehicles.

The first application of the system will be the upgraded AMX-30 MBTs of the Spanish Army

The principle of operation of the SBBR is similar to that of the Blazer explosive reactive armour covered earlier in this section under Israel.

The SBBR is a modular explosive reactive armour system with simple

assembly due to standardised sizes and its original anchorage systems. It can be fitted to virtually all types of armoured vehicle without expensive remodelling.

According to SANTA BARBARA, their explosive reactive armour system helps to increase the protection of the armoured fighting vehicle by reducing the penetration of a HEAT charge by 95 per cent. Variables influencing the efficiency of the system are the weight of the vehicle hull, type of charge and angle of incidence. Vehicle hull thickness should be equal to or greater than 20 mm of steel or 35 mm of aluminium.

The modules consist of two steel plates which box in the explosive sheet. A sealed silicon rubber gasket ensures perfect watertightness and three anchorage points are used to attach the upper panel while three anchorage points pass through drill holes to the lower module.

The modules have the following features, detonation by hollow charges, insensitivity to the impact of kinetic energy ammunition, insensitivity to chain detonation, high heat and direct fire resistance and high corrosion and moisture resistance.

SANTA BARBARA has developed several dynamic protection modules that are compatible with the panels to meet different operational requirements: MDPA1 -5 mm thick steel, hardness over 600 HB, weight of panel 2.2 kg, surface density 37 kg/m²

MDPA2 – 10 mm thick steel, hardness over 600 HB, weight of panel 4.4 kg, surface density 74 kg/m²

MDPC1 – 26 mm thick aluminium and alumina, weight of panel 2.76 kg, surface density 46.5 kg/m²

MDPC2 - 42 mm thick steel and aluminium, weight of panel 7.30 kg, surface density 125.2 kg/m².

The MDPA1 and MDPC1 provide protection against attack from the MILAN 1 ATGW and 106 mm recoilless rifles. In addition to providing protection against chemical energy attack, the panels also provide some protection against kinetic energy attack.

If required, two layers of explosive reactive armour modules can be fitted for increased battlefield survivability. Each module is 250 mm \times 100 mm, although in some cases mechanical or visual obstruction may require the use of a smaller module.

Status: Development complete. In production for Spanish Army.

Manufacturer: SANTA BARBARA SA, Julian Camarillo 32, E-28037 Madrid, Spain

Telephone: (91) 585 01 00 Telex: 23228 ENSAB E Fax: (91) 585 02 68

SANTA BARBARA SABBLIC Passive Armour

Development/Description

In mid-1992, SANTA BARBARA announced that it had developed, as a private venture, a new passive armour system called the SABBLIC (SAnta Barbara BLIndaje Ceramico) to be installed on light and medium armoured vehicles providing protection against medium kinetic energy rounds.

It has a simple vehicle anchorage system and its low weight (89 kg/m²) and thickness (around 30 mm), allow it to be applied to most vehicles without expensive remodelling work.

According to SANTA BARBARA, SABBLIC is a highly efficient armour system with a weight saving approaching 50 per cent when compared to traditional metallic armours.

Its modular construction and standardised attachment mechanism allows any damaged modules to be replaced under field conditions.

SABBLIC has been evaluated by the Spanish Army for installation on the Spanish built BMR 3560.50 (6 \times 6) armoured personnel carrier and it has been tested against a wide range of light and medium calibre projectiles including 7.62 mm AP, 12.7 mm AP, 14.5 mm API, 20 mm AP and 20 mm APDS.

SABBLIC consists of a sandwich with a cover plate and a back-plate between which is a brittle material to absorb and break up the penetrator. SABBLIC defeats impact as close as eight calibres from each shot and seven calibres from the panel edge. It also provides a high degree of protection against blast, shell and mine fragments.

Status: Development complete. Ready for production on receipt of orders.

Manufacturer: SANTA BARBARA SA, Julian Camarillo 32, E-28037 Madrid, Spain.

Telephone: (91) 585 01 00 Telex: 23228 ENSAB E Fax: (91) 585 02 68

SWEDEN

Swedish Steel ARMOX Armour

Development/Description

For many years Swedish Steel Oxelösund has been supplying armour plate manufactured by the continuous roller quenching method which has enabled a new type of armour plate to be produced with a lower content of alloying elements.

This is sold under the trade name of ARMOX and has been supplied for a wide range of armoured vehicle programmes including armoured personnel carriers and MBT's.

It has been approved by and delivered to a number of countries including France, Germany, Sweden, the UK and the USA.

Thickness	Hardness
6-20 mm	480-540 HB
5-40 mm	400-460 HB
5-60 mm	280-340 HB
5.5-20 mm	477-534 HB
20-50 mm	477-534 HB
5.5-12.7 mm	341-388 HB
12.7-19.1 mm	331-375 HB
19.1-31.8 mm	321-375 HB
31.8-50.8 mm	293-331 HB
50.8-80 mm	269-311 HB
5-15 mm	375-429 HB
15-35 mm	302-352 HB
35-70 mm	262-311 HB
70-80 mm	262-302 HB
	6-20 mm 5-40 mm 5-60 mm 5.5-20 mm 20-50 mm 5.5-12.7 mm 12.7-19.1 mm 19.1-31.8 mm 31.8-50.8 mm 50.8-80 mm 5-15 mm 15-35 mm 35-70 mm

Status: Production as required. Supplied to numerous manufacturers worldwide.

Manufacturer: SSAB Oxelösund, Box 1000, S-613 80 Oxelösund, Sweden. Telephone: (46) 155 540 00 Telex: 50950 ssab s Fax: (46) 155 540 73

SPECIFICATIONS		
Grade	Thickness	Hardness
ARMOX 500 S	5-20 mm	480-540 HB
	20-40 mm	450-500 HB
	40-60 mm	420-480 HB
ARMOX 560 S	10-20 mm	530-590 HB
	20-40 mm	500-560 HB
ARMOX 370 S	5-13 mm	380-430 HB
(French standard)	13-22 mm	350-400 HB
	22-35 mm	320-370 HB
	35-80 mm	280-330 HB
TL 23500-0000	5-40 mm	480-530 HB
(German standard)	5-37 mm	380-430 HB
	57-80 mm	330-380 HB
	5-80 mm	280-330 HB

UNITED KINGDOM

British AFV Armour Upgrades for Middle East

Development/Description

For Operation Desert Storm, the liberation of Kuwait early in 1991, many of the British Army's AFVs were fitted with additional armour packages to improve their battlefield survivability.

The explosive reactive armour (ROMOR A) was designed and manufactured by Royal Ordnance while the passive armour was designed and manufactured by Vickers Defence Systems. Vehicle prime contractors, including GKN Defence, were also involved in the programme, as was the Defence Research Agency and other UK establishments.

Following the end of the Gulf Conflict these armour packages were removed and placed in store. In the case of the Warrior, they were refitted when vehicles were deployed to the former Yugoslavia in 1992.

Vickers Defence Systems Challenger 1 MBT

This was fitted with new passive side armour skirts of different thicknesses, the maximum thickness being given to the area forward of the engine compartment.

Explosive reactive armour was provided for the nose of the tank with additional passive armour being fitted to the glacis plate.

GKN Defence Warrior MCV

This was fitted with additional passive armour protection to the front and sides

A contract for the appliqué armour kits was received by GKN Defence on

19 October 1990, and design and development, including firing trials, was completed by 4 January 1991. All armour kits were delivered to the Gulf and fitted prior to the ground offensive on 24 February 1991.

In order to fit the appliqué armour to the newly deployed Warrior Observation Post Vehicle, special brackets for a number of the new vehicles were ordered on a Thursday, designed Thursday/Friday, manufactured Friday/Saturday, fitted overnight by the Royal Electrical and Mechanical Engineers and vehicles despatched to the Gulf on the Sunday.

Chieftain AVRE and AVLB

The standard skirts were replaced by new passive armoured skirts similar to those on Challenger 1 MBT.

Centurion AVRE

A complete new explosive reactive armour package was developed for the vehicle covering the forward part of the turret and the front of the hull.

GKN Defence FV432 APC

No up-armour packages were fielded for the FV432 family of vehicles manufactured by GKN Defence although some vehicles were fitted with additional lateral protection by installing the side skirts removed from Challenger 1 MBTs when they were fitted with new armoured side skirts.

Alvis Scorpion

No new armour kits were fielded for the Combat Vehicle Reconnaissance (Tracked) Scorpion family of vehicles.



Challenger 1 MBT deployed in Operation Desert Storm, showing additional explosive reactive and passive armour protection (MoD, Crown Copyright)



Warrior mechanised combat vehicle deployed in Operation Desert Storm showing additional passive armour protection (MoD, Crown Copyright)

Alcan Plate Aluminium Armour

Development/Description

The United States was the first country to make extensive use of aluminium armour, with the Type 5083 being used in the M113 series of armoured vehicles. Using the first-generation Types 5083 and 7039 aluminium armours, designers were able to take advantage of up to 20 per cent weight saving over steel without reducing protection levels.

Taking early US experience as a starting point, since 1960 Alcan Plate, Alcan Speciality and Aerospace Limited, has developed a range of alloys for armoured vehicle applications. A good example is the heat treatable 7039 alloy which gives good ballistic protection but was prone to stress corrosion. Alcan Plate developed this alloy further into the ballistically stronger and more stress corrosion-resistant 7017 alloy which has been used on Scorpion, Fox, CET and BMR-600 and, more recently, the hull of the Warrior and Stormer vehicles.

Where fragmentation attack from mine and shell burst is a design consideration the heat treatable 7018 alloy has been deliberately designed to provide the same levels of strength and toughness but with 50 per cent higher welded joint strength than the 5083.

Current Alcan aluminium armours include:

Type 7017 for high strength armour plate where high penetration resistance is required. UK specification MVEE 1318.

Type 7039 for high strength armour plate. US specification MIL-A-46063. Type 7020 for medium strength armour plate where combined penetration resistance and ballistic toughness are required. French specification DTAT/AMX/ISB/250. German specification BWB.TL.2350-04.

Type 7018 for ballistically tougher but less penetration resistant armour. specifically designed as a heat treatable alternative to 5083 H115. UK specifications MVEE 813.

Type 5083 in H115 temper for tough armour plate. UK specification MVEE 570. US specification MIL-A-46027.

The main advantage of aluminium armour over conventional steel armour is that it is lighter. To provide strength or the ballistic protection equivalent to that of steel armour, aluminium armour plate needs to be between two and three times thicker and will therefore provide a much stiffer structure than one made of steel. This enables stiffening and reinforcement members to be eliminated or drastically reduced, so making significant reductions in structural weight.

All Alcan alloys can be readily welded by the inert gas TIG and MIG methods. Although with Type 5083 there is a loss of strength in the weld zone, with the remaining alloys a high proportion of the strength recovers after natural ageing

All plate is supplied with sawn edges and profiling can be carried out by band sawing or plasma arc cutting, with the latter being recommended as speed of up to 1.2 m/min with cuts 3 to 5° of square are possible. The Type 7000 series alloys can be machined using conventional tools but at speeds much higher than those for steel. For example high-speed routeing can remove up to 1300 cm3 of metal per minute.

Alcan has developed special production techniques which markedly reduce the susceptibility of 7000 series alloys to stress corrosion cracking. Stress corrosion cracking is aggravated by internal stresses which can be set up by forming or welding unless certain procedures are adopted during fabrication.

Alcan alloy armour is used in a number of vehicles including:

178 ARMOUR SYSTEMS / UK

Alvis CVR(T) Scorpion family (hull and turret) Alvis Stormer family BMR-600 (6 × 6) IFV Daewoo Korean Infantry Fighting Vehicle FMC AIFV (Belgian and Dutch built vehicles) FMC M113 series FMC M2 Bradley Giat Industries AMX-10P family GKN Defence Warrior OTO Melara Palmaria SPG

Royal Ordnance/Vickers Defence Systems Fox Royal Ordnance Combat Engineer Tractor Spanish M113 retrofits

Status: Production as required.

Manufacturer: Alcan Plate, Alcan Speciality and Aerospace Limited, PO

Box 383, Kitts Green, Birmingham B33 9QR, UK. Telephone: (021) 783 4020 Telex: 337417 Fax: (021) 784 7899

Alloy	Temper	Thickness	Width	Maximum	Maximum cre		
Availability							
5083	4 ³ / ₄ Mg ¹ / ₃ Mn	H115	290	42.1	360	52.2	12
7020	43/4Zn 1/8Mg 1/3Mn	T651	360	52.2	400	58.0	12
7018	43/4Zn 1Mg 1/3Mn	T7651	300	43.5	360	52.2	12
7039	4Zn 21/2Mg 1/3Mn	T651	400	58.0	460	66.7	11
7017	5Zn 21/2Mg 1/3Mn	T651	425	61.6	485	70.3	10
	% by weight		MPa	ksi	MPa	ksi	%
	(1101111121)		stress		stress		
	(Nominal)		Proof		tensile		
Alloy	Composition	Temper	0.2%		Ultimate		Elongation
SPECIFICATION	ie.						

Alloy	Temper	Thickness (mm)	Width (mm)	Maximum length (mm)	Maximum cross- section area (mm²)
7017	T651				
7039	T651	6.35-12.5	250-1800	16000	151 500
7018	T7651	12.5-150	250-2080	14 000	13 0000
7020	T651	6.35-12.7	250-2134	17850	-
5083	H115	12.71-100	250-2050*	14 000	130 000*

^{*} Greater widths up to 3300 mm and maximum cross-section 150 000 mm² may be available as the above limits are not absolute. Larger sizes may be available subject to enquiry.



Alvis Scorpion CVR(T) has a hull and turret of welded Alcan Plate aluminium



The GKN Defence Warrior mechanised combat vehicle has a steel turret and a welded Alcan Plate aluminium armour hull

British Steel Armour

Development

The Cyclops facility of British Steel Stainless has been working on the design and manufacture of armour plate for a variety of applications for many years and is currently engaged in the production of three main types:

CP 30, a conventional armour 3 to 80 mm thick

This is used in a wide variety of armoured fighting vehicles and is manufactured from 1.5 per cent Cr-Mo steel.

Hykro, a conventional armour 81 to 150 mm thick

This plate is used in a variety of roles including special protection duties and in the areas of proof of projectile testing. Both CP 30 and Hykro armour plate are manufactured to British MoD specifications but other specifications can be supplied. Plate sizes of up to a maximum of 3 m wide and 8 m long can be produced and supplied in rectangular, profiled and/or finished machined condition, both the latter conditions include full edge preparation, flattening and so on as required.

CP 50, a high hardness armour 3 to 40 mm thick

This is used for lightweight armoured vehicles such as the Simba. It is manufactured from 1.5 per cent Cr-Mo steel, 500 HB hard armour and is



GKN Defence Simba (4 × 4) light armoured vehicle uses steel produced by British Steel Armour Limited

produced in plate sizes up to a maximum 3 m wide and 8 m long. It can be supplied in the rectangular, profiled and/or finished machined condition with both of the latter conditions including full edge preparation, flattening and so on as required. Plates of up to 40 mm thickness are supplied to a hardness range of 470/530 HB in the centre of the plate thickness. Typical tensile properties are as follows:

YIELD STRENGTHS UTS

1350 N/mm

ELONGATION REDUCTION IN AREA 8% 45%

Status: Production. In service with the British Army and other undisclosed armed forces.

Manufacturer: British Steel Stainless Limited, Armour & Associated Products, Cyclops, Carlisle Street, Sheffield S4 7LJ, UK.

Telephone: (0742) 430513 Telex: 547025 Fax: (0742) 728445

Royal Ordnance ROMOR Appliqué Armour Systems

Development

In 1985 Royal Ordnance Nottingham, with the assistance of a number of other Royal Ordnance facilities, started development work on the ROMOR series of armour packages.

The first of four, ROMOR A, is an explosive reactive armour package. ROMOR B is a passive armour package. The existence of ROMOR A and B was first revealed at the 1986 British Army Equipment Exhibition when a Chinese Type 59 MBT was shown fitted with ROMOR B on its turret front and glacis plate with ROMOR A in a vertical position above the forward roadwheels.

Royal Ordnance Glascoed developed the explosive filling for ROMOR A while the Future Systems Group at Shrivenham provided statistical information from computer modelling in survivability. Information on shaped charge warheads was provided by Chorley and Patricroft.

The Royal Ordnance ROMOR C passive armour has been developed over the period 1986 to 1991 and is also now ready for production on receipt of orders.

Description

The principle of operation of ROMOR A is the same as that for the Israeli Blazer explosive reactive armour system (qv). The explosive used in ROMOR A is Demex 200 which is said to be naturally insensitive and intrinsically safe.

Royal Ordnance supplied ROMOR A explosive reactive armour to the British Army for installation on a number of vehicles during Operation Desert Storm (qv) and late in 1991 RO stated that Japan had placed an order for the supply of ROMOR A for home trials. ROMOR C is a family of passive armours which utilise high performance ceramic and composite materials and the latest composite manufacturing technology. It can be designed as part of the main vehicle structure, as large moulded sections or retrofitted to existing vehicles in a panel format.

ROMOR C is available in a multifude of configurations to defeat 5.56 mm, 7.62 mm, 12.7 mm, 14.5 mm and up to 30 mm APFSDS rounds with significant weight advantages over RHA and spaced armours. ROMOR D is being developed for future use as an active or dynamic system which operates in response to a sensed threat. The use of stealth materials to evade detection is also being developed.

The main advantages of the ROMOR A appliqué explosive reactive armour have been summarised by Royal Ordnance as:

- (1) reduces the performance of, for example, a 127 mm shaped charge by over 75 per cent and is effective against a wide range of weapons
- (2) it is not activated by small arms fire

- (3) it can be cut or drilled without risk of detonation
- (4) panels are easy to store and handle
- (5) it can be installed in the field without specialist tools
- (6) minimal effect on vehicle handling and suspension.

Status:

ROMOR A - production as required. Sold to British Army and Japan.

ROMOR B - development complete.

ROMOR C - development complete.

ROMOR D - still under development.

Manufacturer: Royal Ordnance Division, Kings Meadow Road, Nottingham NG2 1EQ, UK.

Telephone: (0602) 863341 Telex: 37531 Fax: (0602) 861436



Royal Ordnance ROMOR A explosive reactive armour being fitted to tank turret

Vickers Defence Systems VARMA Armour Systems

Development

Vickers Defence Systems has been involved in the design and development of a wide range of armour systems for some years and is the sole supplier for advanced armours such as Chobham and Stillbrew (qv) for the British Army.

According to Vickers Defence Systems, the Chobham armour installed on the Challenger 2 MBT now entering production for the British Army is the toughest and strongest special armour in the world. This provides the best protection against both kinetic and chemical energy projectiles and has the unique capability to tolerate multiple hits.

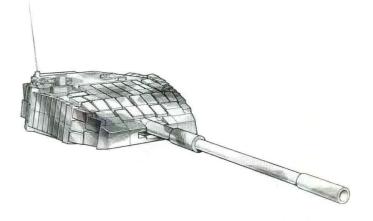
Vickers Defence Systems has used the experience gained on funded UK MoD armour projects to develop a range of private venture armour products called VARMA. The VARMA range of armour products is suitable for both retrofit in service vehicles and for integration into new vehicle concepts.

Vickers Defence Systems supplied passive armour to the British Army for installation on a number of vehicles during Operation Desert Storm (qv).

VARMA Series 1

VARMA 1 is a compact armour which is highly effective against kinetic energy threats such as APFSDS and chemical threats such as HESH and HEAT.

The system incorporates ballistically proven armour array packages that can be tailored to fit existing vehicles even when complex curved surfaces



Artist's impression of VARMA Series 2 explosive reactive armour fitted to tank turret

are involved. VARMA 1 can be supplied to virtually any cast turreted vehicle including M48, M60, former Soviet and Chinese T series, Chieftain and Centurion.

VARMA Series 2

VARMA 2 is an explosive armour system which offers a very high degree of performance against shaped charge weapons. The armour is lightweight, easily installed and is a very cost-effective means of providing protection against shaped charge threats.

VARMA Series 3

VARMA Series 3 is a series of lightweight armour systems that can be optimised to defeat a range of small calibre kinetic energy and shaped charge weapons.

VARMA Series 4

VARMA 4 is an explosive armour system developed specifically to protect the turret roof of MBTs against shaped charge threats.

Status: Production as required

Manufacturer: Vickers Defence Systems, Scotswood Road, Newcastle-

upon-Tyne NE99 1BX, UK.

Telephone: (091) 273 888 Telex: 53104 Fax: (091) 273 2324



M48A5 tank turret fitted with VARMA Series 1 passive armour either side of turret and protecting vulnerable gap between hull and turret, with VARMA Series 2 explosive reactive armour fitted to gun mantlet and on sides of turret to immediate rear of VARMA Series 1 armour

Vickers Defence Systems Stillbrew Passive Armour System

Development

The Stillbrew passive armour system was originally conceived at the Royal Armament Research and Development Establishment (RARDE), Chertsey, where Chobham armour was first developed over 25 years ago.

RARDE (Chertsey) made presentations of the new passive armour, later named Stillbrew, to the British Army with the idea of improving the armour protection of the British Army's MBT fleet. At that time there was no formal requirement for additional armour protection for Chieftain.

Royal Ordnance Leeds (now Vickers Defence Systems) became involved in transferring the armour system from concept to a viable engineering solution for Chieftain. Firing trials against the new passive armour mounted in stands had successfully taken place.

A formal development contract was placed with Leeds by project manager Chieftain with RARDE (Chertsey) being principal subcontractor.

A short time after the contract was placed, RARDE and Leeds had designed and built the first armour system to be installed on a Chieftain and this vehicle went to the ranges for firing trials. These and subsequent trials demonstrated that the new passive armour exceeded all of the requirements of the General Staff Target.

In 1985 two Chieftains were each subjected to mobility trials, half on roads and half cross-country. One of these trials was conducted at the Armoured Trials and Development Unit (ATDU) at Bovington Camp, Dorset, and the other at RARDE (Chertsey). These showed that there is no degradation in the vehicle's mobility as a result of the additional armour, although its power-to-weight ratio is slightly reduced.

It is believed that the British Army gave early acceptance of the new armour package which allowed Leeds to start producing the armour system in production quantities.

Final acceptance was given in 1986 by which time 23 Base Workshop was already involved as the armour is fitted when the Chieftains return for normal base overhaul.

One of the users' requirements was that damaged sections could be replaced in the field without specialised REME lifting equipment and trials have demonstrated that this could be achieved.

In 1986, 23 Base Workshop, Royal Electrical and Mechanical Engineers,

Wetter, Germany, started to fit Chieftains of BAOR with Stillbrew appliqué armour.

Description

No details of the actual Stillbrew passive armour have been released but it is probably an outdoor shell of steel with layers of composite or ceramic armour behind.

On Chieftain, Stillbrew is fitted in sections over the frontal 180° of the turret and on the hull top to the rear of the driver's position to give additional protection to the gap between the turret and hull.

Status: Production complete. In service with British Army on Chieftain MBTs.

Manufacturer: Vickers Defence Systems, Manston Lane, Crossgates, Leeds LS15 8ST, UK.

Telephone: (0532) 648123 Telex: 55134 Fax: (0532) 607674



Chieftain MBT of 1st Armoured Division fitted with Stillbrew passive armour system (1st Armoured Division)

UNITED STATES OF AMERICA

Protection of US Armoured Vehicles

Early in 1989 it was revealed that a new technology relying on electromagnetic energy for both armour and armour-piercing weapons was being developed under the auspices of the Defense Advanced Research Projects Agency, the Defense Nuclear Agency and the United States Tank Automotive Command.

Electromagnetic armour may be lighter than the current explosive reactive armour and could be fitted to MBTs armed with electromagnetic or electrothermal weapons (qv AFV Armament section). Both the armour system and the armour would use the same power source.

The basic idea is that an electrical field would be created between the outer plate and the hull of the vehicle.

The US Army is also working on composite glass and ceramic armour

which will be shaped into box like structures and attached to the outside of vehicles to provide increased protection against both kinetic energy and shaped charge projectiles.

It was also revealed in mid-1989 that Kaman Sciences had been awarded a \$6.2 million research and development contract from the Defense Advanced Research Projects Agency, working with SNPE of France under Nunn Amendment funding. Under the terms of this contract the two companies will develop an advanced explosive reactive armour system that can be fitted to light and heavy armoured vehicles. The system will consist of a family of cassettes which will disrupt a variety of threats including kinetic energy and shaped charge projectiles (including tandem warheads). More recently, SNPE and Kaman have been awarded a contract for ERA tiles for the Bradley IFV and additional details are given in this section under France as well as this section under the Advanced Energetic Corporation of America (AEMC).

ALCOA Composites M113 Modular Up-Armour

Development/Description

As a private venture, ALCOA Armor Systems Division has developed a supplemental armour kit for the widely deployed M113 series of APC which provides protection against Kinetic Energy (KE) threats through 14.5 mm and chemical energy threats.

The exterior kit consists of perforated superhard steel stand-off armour which is bolted to the aluminium hull using a unique 'X' brace mounting system for structural ruggedness.

The system is modular and allows rapid installation by two people and easy replacement of damaged panels or sections. It provides protection through 360° against kinetic energy threats through the 14.5 mm MS41 at a range of 300 m by breaking up and dispersing projectile fragments. Total weight of the system is 771 kg.



M113 series APC fitted with ALCOA Composites M113 modular up-armour kit (above) and section through vehicle to show main components (right)

The interior kit consists of a spall liner that is made in panels mounted in rails just behind the crew area seats and to the roof. Panels slide in rails for access to equipment and stowage.

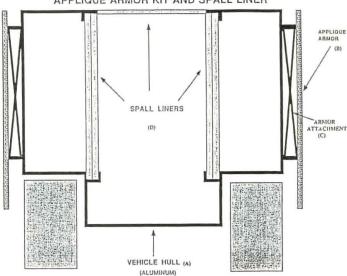
Spall liner panels are manufactured using ballistic glass or aramid fibres and the appropriate polymer resin system. The spall liner catches fragments from the hull and greatly reduces the shape charge jet. Total weight of the kit is 363 ka

In addition to the M113 modular up-armour kit, ALCOA Composites has been involved in a number of other up-armouring programmes including the design of the M88A1E1 armoured recovery vehicle (under subcontract to BMY Combat Systems) and a composite appliqué armour system for the Delco LAV 25 under contract to Delco Systems.

Status: Development complete. Ready for production.

Manufacturer: FIBERTEK Division of ALCOA Composites Inc, 1180 North Mountain Springs Parkway, Springville, Utah 84663-0910, USA. Telephone: (801) 489 3672 Fax: (801) 489 3671

> M113 APPLIQUE ARMOR KIT AND SPALL LINER



Alliant Techsystems Advanced Armour Systems

Development/Description

Although Alliant Techsystems are well known for their extensive involvement in the design, development and production of ammunition and other weapon systems, they are also involved in armour programmes.

The company's extensive involvement in developing anti-armour systems. including Kinetic Energy (KE) and Chemical Energy (CE) threats for medium calibre and tank ammunition rounds, Explosively Formed Penetrator (EFP) threats for such programmes as the Sense And Destroy Armor Munition (SADARM) and the Smart Target Activated Fire and Forget (STAFF) round, have proved invaluable in Alliant Techsystems development of advanced armour systems

In order to develop effective threats, Alliant Techsystems have had to develop appropriate targets. They have extensive simulation capabilities to accomplish these tasks. Their Epic modelling provides 3D simulation of complex long-rod penetrators interacting with hybrid targets.

Late in 1991, Alliant Techsystems stated that it was currently under contract with DARPA on the 'Blue Armor' programme to develop high tech armour for future vehicles. The objective of this programme is to significantly improve the survivability of armoured vehicles against KE and CE attack.

To accomplish this the company is combining advanced explosive reactive armour concepts with new packaging for improved passive materials and modularity. The company is pursuing a number of other programmes and developed light armour for overhead fragmentation protection.

On the 'Blue Armor' programme, Phase 1 armour targets outperformed the competitors at the Los Alamos test range and at a much lower weight.

Phase 2 is continuing with the build of light, medium and heavy targets for US Government test

Status: Development.

Manufacturer: Alliant Techsystems Inc, Defense Systems, 7225 Northland Drive, Brooklyn Park, Minnesota 55428, USA. Telephone: (612) 536 4547 Fax: (612) 536 4545

Chamberlain Armor Protection System (CHAPS)

Development/Description

Under the overall title of CHAPS (CHamberlain Armor Protection System), the Chamberlain Manufacturing Corporation is now marketing two armour systems, one for APCs and one for MBTs.

The APC system is a passive armour and is essentially the proven RAFAEL Togo system covered earlier under Israel while the MBT system is the combat proven Blazer explosive reactive armour system jointly marketed by TAAS - Israel Industries Ltd and the RAFAEL Armament Development Authority; this is also covered under Israel.

The Chamberlain Manufacturing Corporation market CHAPS in selected parts of the world and with their extensive experience in the design and manufacture of ammunition have the capability to manufacture both systems in their US facilities.

Status: Development complete. Production as required.

Manufacturer: Chamberlain Manufacturing Corporation, International Marketing Office, 2201 Jefferson Davis Highway, Crystal Plaza 1, Suite 405, Arlington, Virginia 22202, USA.

Telephone: (703) 415 0754 Fax: (0703) 415 0758

Composite Armored Vehicle (CAV)

Development/Description

Late in 1991 it was revealed that the US Army was looking to develop a new fleet of armoured fighting vehicles that would weigh 25 to 30 tons (US) and be virtually undetectable to enemy missiles and radar.

Key elements of this programme are said to include composite materials. electric drive systems and more powerful weapon systems which could include electrothermal or electromagnetic types with a significant increase in armour penetration characteristics, and have a lower crew requirement.

The first vehicles to incorporate some part of this technology could be the US Army's Future Scout Vehicle and Light Infantry Fighting Vehicle that could be deployed as early as 2005.

In mid-1992, the US Army Tank Automotive Command awarded two contracts to study the design of the first ever composite armoured vehicles designed from the ground up.

TACOM's Composite Armored Vehicle (CAV) programme exemplified the US Government's new co-operative research and development focus on Advanced Technology Demonstration (ATD) systems.

The phase one CAV contracts, which run through to September 1994, were awarded to the FMC Corporation, who currently manufacture the Bradley Fighting Vehicle, and General Dynamics, Land Systems Division, who manufacture the M1A1 MBT.

There are two key goals of the Army's new CAV programme, first whether or not reduced signature vehicles are practical and second whether composites are practical for use in combat vehicles.

Prior composite vehicle development programmes in the US have included a composite Bradley infantry fighting vehicle hull as well as US Marine Corps composite vehicle efforts, including a M113 vehicle. Both of these initiatives have provided a notional database that is feeding into the CAV programme.

Of the seven new science and technology thrust areas, thrust five covers Advanced Land Combat (ALC) which is broken down further into separate areas.

TACOM will have proponency for the area known as Advanced Vehicle Technologies while US Army Missile Command will have proponency for Rapid Force Projection Initiatives.

Both of these areas feature multiple ATD programmes. The CAV is one of six advanced technology demonstration programmes included under the Advanced Vehicle Technologies (AVT) area.

The first phase of the CAV program will allow industry scientists and engineers to consider various composites materials and technologies to determine the optimum approach for use in combat vehicles.

Scope of work for the complete programme will include concept designs, material test sections and ballistic test sections.

The CAV follow-on effort emphasises a joint development process with close co-operation between TACOM, the Defense Advanced Research Projects Agency (DARPA) and the US Marine Corps. Current projections indicate a follow-on solicitation in late FY93 or early FY94 to actually build a CAV ATD together with another ATD known as the Light Contingency Vehicle (LCV).

The LCV is a DARPA programme that is being examined in parallel to TACOM's CAV initiative. As currently envisioned, the CAV will have a gross weight (GVW) of about 22 tons (US) while the LCV will have a GVW of only 8 to 12 tons (US).

Both TACOM and the US Marine Corps will provide DARPA with Deputy Programme Managers to serve as joint technical managers under current program plans.

According to TACOM officials, there are multiple advantages of a joint solicitation for these two ATD programmes. For example, given different vehicle weights, responses may provide two separate technical approaches and give the government the best opportunity of competing two separate technologies.

Status: Early development, see text.

Manufacturer: Not selected.

Composite Developments

Development/Description

Composites have been used in a wide range of military applications in the USA for over 25 years including, for example, helicopter seats. For a number of years the US Army Materiels Technology Laboratory (MTL), with the assistance of private industry, has been seeking wider applications for composite materials.

According to MTL there are a number of advantages of using composite structural armour in place of aluminium in medium weight combat vehicles.

MTL has already developed a composite turret and is involved in developing a composite hull for the Composite Infantry Fighting Vehicle which, in 1987, was included in the Top 20 list of the high priority US Army demonstration projects.

Composites will also be considered in future US Army armoured fighting vehicles and were applied to the Army's 155 mm Lightweight Howitzer Programme co-ordinated with the Army's Armament Research, Development and Engineering Centre at Dover, New Jersey. This project was however cancelled owing to a shortage of funding before the first complete prototype system had been completed.

In September 1986 MTL awarded a \$13 million, four year contract to FMC's Advanced Systems Center to design, analyse, fabricate and test two Bradley Infantry Fighting Vehicles made from lightweight composite materials which will be used as a test-bed to provide materials technology for future generations of US Army combat vehicles. Under this contract, FMC conducted materials and processing refinement, hull design, tooling fabrication and moulding and outfitting of the hull.

The composite selected for this project consists of resin-bonded Owens-Cornings S-2 glass fibre woven fabric. In fabricating the composite hull structure, three moulded sections replaced 23 welded aluminium plates while still incorporating aluminium reinforcing members for strength.

FMC's Advanced Systems Center rolled out the prototype of the Composite

Bradley in the Summer of 1989 and under the 1986 contract a total of two hulls have been built. The first prototype has been fitted with a standard Bradley two-man power-operated turret armed with a 25 mm M242 cannon, 7.62 mm coaxial machine gun and twin TOW launcher.

When compared to metal hulls, the benefits according to the US Army Materiels Technology Laboratory are:

- 25 per cent weight reduction in full structure and armour weight, equal ballistics
- (2) enhanced crew survivability, no spall, improved resistance to mine blast and explosive reactive armour detonation
- (3) noise and vibration reduced by 5 to 10 dB in crew compartment
- (4) reduced manufacturing costs. It is estimated that costs of fabricating hull structure will be 20 per cent lower because moulding large sections reduces machining/joining
- (5) reduced life-cycle costs from increased fatigue strength and elimination of corrosion and weld problems in metal hulls.

Following the 10 000 km of trials at Camp Roberts with the first vehicle, Phase III will commence. This is the building of the second prototype that will incorporate any design changes learned from the testing of the first prototype.

Other projects currently underway at FMC include a composite hull for a low profile M113A4 for the Canadian armed forces as well as studies for a high survivability MLRS cab, composite turrets for the Block III modification to Bradley and a composite hull for the Block IV Bradley in the year 2000 is a possibility.

Developing agency

US Army Laboratory Command, Materiels Technology Laboratory, Arsenal Street, Watertown, Maryland 02172-0001, USA.



Composite turret for Bradley Infantry Fighting Vehicle built by FMC Corporation prior to installation of weapons, sights and hatches



FMC Corporation Composite Bradley Infantry Fighting Vehicle

US Appliqué Armour Programmes

In the early 1980s the US Marine Corps commenced development of a passive appliqué armour system for its AAV7A1 family of armoured amphibious vehicles.

This is called the P-900 Appliqué Armor Kit (AAK) and comprises a set of punched and perforated armour plates which when fitted to the hull sides and slopes of the AAV7A1 increase its armour protection.

The P-900 AAK is attached to the AAV7A1 in two layers. The first layer is mounted about 150 mm from the hull side and the outer laver 25 mm from that. The armour sheet has a Swiss cheese appearance similar to that of the Israeli Toga appliqué armour system developed by Urdan Industries for use on the M113 series (qv Israel).

When a bullet hits the P-900 armour it is deflected from its trajectory and becomes implanted in the armour and so does not reach the hull of the vehicle. It probably provides protection against APDS rounds fired by automatic weapons up to 14.5 mm in calibre, for example the former Soviet KPV 14.5 mm machine gun which is fitted to many armoured vehicles including the BTR-60 (8 \times 8) APC and the BRDM-2 (4 \times 4) amphibious

Following extensive trials the Naval Sea Systems Command (NavSea) issued the initial Request for Proposals for production P-900 AAKs to industry in the fourth quarter of FY86.

In March 1987 the Majestic Metal Fabricating Company of Roseville, Michigan, was awarded the first production contract worth \$2.84 million and covered the construction and delivery of 189 P-900 kits for use on US Marine Corps AAV7A1 vehicles.



FMC M113A3 APC fitted with P-900 AAK

The first production AAKs were fitted to two reinforced AAV7A1 platoons in each Marine Amphibious Force as well as a single MPS brigade.

Following the AAK is the Enhanced Appliqué Armor Kit (EAAK) which will also be fitted to the command post members of the AAV7A1 family as well as the basic personnel carrier. The EAAK will also provide added protection not only to the sides and slope of the AAV7A1 hull but also the top surfaces and all three crew hatches.

In the Summer of 1989 RAFAEL Armament Development Authority of Israel announced that they had been selected as the sole winner of an open competition to deliver three complete, pre-production Enhanced Appliqué Armor Kits (EAAKs) for the US Marine Corps AAV7A1 amphibious vehicles.

This package provides increased protection for the vehicles hull sides, including the upper sloping part, roof and the three crew hatches.

Following trials with the pre-production EAAK systems a production contract was placed for a total of 1137 kits and final deliveries were made early in 1993.

US Army

The US Army will also install the P-900 system on its new production FMC M113A3 APCs. Due to the different physical characteristics of the M113A3 and the AAV7A1 the armour configurations and shape are different as are the armour attachment points. New production M113A3s are being fitted for but not with P-900 systems.

Status: US Marine Corps, P-900 AAK in service with AAV7A1 vehicles. EAAK selected for AAV7A1 and now being installed (see above). US Army, M113A3 fitted for but not with P-900 AAK.



US Marine Corps AAV7A1 fitted with P-900 AAK

US Army Explosive Reactive Armour Programmes

Development/Description

The US Army started working on explosive reactive armour again in the early 1980s after a series of evaluations of the Israeli Blazer system (qv) fitted to M60A1 MBTs. At least one complete Blazer system was purchased by the US Marine Corps before the 1982 Israeli invasion of the Lebanon and this was followed by the purchase of a further two systems in 1985.

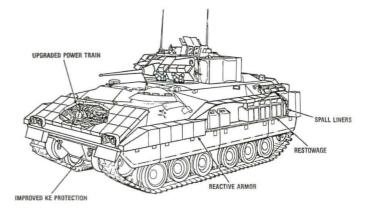
Full-scale development of US explosive reactive armour started in 1982 at the Ballistic Research Laboratory at Aberdeen Proving Grounds. A three year development effort by several of the Army's Material Command agencies followed with conceptual testing being carried out by the Combat Systems Test Activity (CSTA).

By July 1985 development had progressed to such a stage that full-scale testing by CSTA began against three M60A3 tanks supplied by Anniston Army Depot. Additional testing was carried out against three sets of ballistic hulls and chassis. Only a single fully loaded M60A3 had to undergo actual ballistic impact tests. These trials were completed by late 1985 and included the firing of both tank fired projectiles and various anti-tank guided weapons.

The system for the M60A3 was type classified as the M1/M2 Appliqué Armor System (AAS) with each M1/M2 applique armour kit consisting of 95 explosive reactive armour tiles plus associated attachment hardware to allow it to be fitted to the M60A3 and M60A3 TTS (Tank Thermal Sight) MBTs. The total weight of the kit was about 1700 kg and took 140 man

The 95 tile kit included 52 of the smaller M1 tiles weighing a total of 440 kg plus 43 of the larger M2 tiles weighing 560 kg. The remaining 700 kg consisted of the installation hardware.

It was expected that the M1/M2 Appliqué Armor System would be installed initially on M60A3 tanks in service in South Korea in the first quarter of 1988 but in January 1988 the whole programme was cancelled. More recently the US Marine Corps has fitted this ERA package to a number of its M60A1 MBTs. M60A1s with ERA were deployed to Saudi



Drawing of Bradley showing some of the main improvements incorporated in recent production vehicles (not to 1/76th scale)

Arabia by the United States Marine Corps late in 1990. These subsequently took part in Operation Desert Storm. The M60A1 has now been withdrawn from service by the US Marines.

An explosive reactive armour package has also been developed for the M2 Infantry Fighting Vehicle and the M3 Cavalry Fighting Vehicle. This system weighs about 4000 kg and consists of 55 tiles. 19 for the front and 18 either side. The French company of SNPE and Kaman of the USA have been awarded development contracts for ERA packages for the M2/M3 Bradley and details of this are given in this section under France.

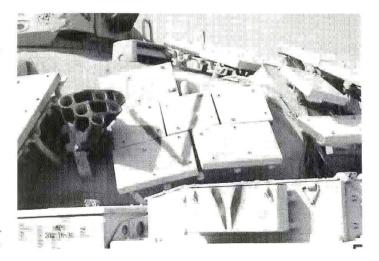
First production of M2 Infantry Fighting Vehicles fitted for but not with explosive reactive armour were completed in the Summer of 1988.

In addition to being fitted for explosive reactive armour, the latest production M2/M3 vehicles have numerous other improvements to enhance their battlefield survivability including improved protection against kinetic energy attack, spall liners and restowed ammunition.

Status: M60A1 – US Marine Corps, but M60A1 has now been withdrawn from service.

M60A3 - fielding cancelled.

M2/M3 – first production vehicles fitted for, but not with explosive reactive armour were completed in the Summer of 1988.



US Marine Corps M60A1 fitted with explosive reactive armour (Christopher F Foss)

DARPA LAV-25 Appliqué Armour System

Development/Description

In April 1992, the US Defense Advanced Research Project Agency (DARPA) stated that it had successfully completed a three month project to take a technology from the proof-of-principle concept to a fieldable prototype system within three months.

The object of this \$2 million effort is to provide 75 prototype kits of Light Appliqué System Technique (LAST) to the Marine Corps for application to Light Armored Vehicles (LAVs) deployed with both marine and army forces operating in Operation Desert Shield/Desert Storm.

The LAST is a unique attachment system for appliqué armours. Foster-Miller Inc, under contract to DARPA, developed the system which consists of a hook-and-a-loop attachment system (Velco USA), armour modules (Lanxide Armor Products, Newark, Delaware and Coors Ceramics, Golden, Colorado) and a protective cover (Bell Avon, Picayune, Mississippi).

The key features that make the system so attractive for the LAV-25 are its light weight and ease of installation and repair. The hook-and-loop attachment is affixed to the vehicle with pressure-sensitive adhesive.

Consequently no modification of the structure of the vehicle, such as drilling or welding, is required.

Prototype LAST kits consist of the LAST system, ceramic armour tiles, a battle damage repair kit and a manual with a videotape providing instructions on kit installation.

A total of 60 000 ceramic armour tiles were produced in less than 90 days. These had to undergo ballistic validation testing to verify tile performance. The LAST system underwent development testing and a LAV with a LAST armour kit underwent live fire testing and was also tested against chemical agents. All this took place during the 90 day effort.

While the timing of the ground war in the Gulf made it impossible to field prototype LAST systems in support of Operation Desert Storm as planned, the Marine Corps has decided to equip marine units on both the East and West Coast with LAST kits for continued test and evaluation.

Status: Development complete. In limited service with the US Marine Corps (see text).

Manufacturers: Various (see text).

Martin Marietta Composite Armour

Development/Description

In 1985 Martin Marietta Aerospace delivered an M113 series APC with a lightweight composite hull to the US Marine Corps for extensive trials as part of its amphibious vehicle development programme.

The \$960 000 contract was awarded by the Marine Corps Programmes Office of the David W Taylor Naval Ship Research and Development Center, Maryland. The Martin Marietta-built hull was outfitted with government furnished equipment, fittings and suspension which are identical to the standard US Army M113.

The hull is made of E glass woven roving laminate reinforced plastic material with ceramic tiles which are 18 mm thick on the sides and 32 mm thick on the roof. The upper hull is joined to the aluminium lower hull through a bonded and bolted lapjoint.

The tiles are attached to the composite hull in two ways. First by tape which permits quick replacement of the tiles if they become damaged and second by epoxy cement which provides a stronger bond.

The openings in the upper hull are surrounded by aluminium frames to protect the edges of the glass reinforced plastic laminate and provide a strong and workable interface between the standard hatches on the hull.

According to Martin Marietta this armour provides greater protection than aluminium armour plate at equal or lighter weight, which can be critical in amphibious vehicles.

This contract was awarded to Martin Marietta Aerospace as part of the US Marine Corps Surface Mobility Exploratory Development Programme to demonstrate feasibility and affordability under acceptable maintenance and repair conditions of technology developed for future amphibious vehicles.

Status: Prototype delivered to US Marine Corps for trials.

Manufacturer: Martin Marietta Aerospace and Naval Systems, 103 Chesapeake Park Plaza, Baltimore, Maryland 21220, USA.

Telephone: (301) 338 5000 Telex: 710 2399 049



M113 APC with advanced composite hull designed and built by Martin Marietta during company trials

Protective Materials Company M113 Spall Suppressant Armour System

Development/Description

The hull of the FMC M113 series of APC, of which over 74 000 have now been built in the United States, provides the crew with protection from small arms fire and shell splinters. Modern shaped charge (or HEAT) munitions have no difficulty in penetrating the aluminium hull and creating a secondary and more devastating threat to the personnel and equipment inside the vehicle by effecting the cone dispersal pattern of aluminium wall fragments

(or spall) which ricochet at high velocities throughout the vehicle interior. To provide increased protection for the M113 series the US Army Materials Technology Laboratory with the co-operation and technical support of the FMC Corporation and the Protective Materials Company, developed the spall suppressant armour liner for use in the latest M113A3 version as well as the M2 Bradley IFV.

The Protective Materials Company was selected as the prime contractor to FMC Corporation to produce the prototypes of the liner which were then tested by Tank Automotive Command and the Ballistic Research Laboratories.

Trials demonstrated that the prototype liners produced by Protective

Materials Company to the US Army design criteria effected a nearly 100 per cent reduction in the amount of spall during the simulated shaped charge attack. In addition the liner was also found to reduce the blast induced pressure and luminance which typically results from ballistic attacks on aluminium armoured vehicles.

In addition to being currently in production for new build M113A3 APCs they can also be backfitted to older M113 vehicles.

For the export market FMC and its component subcontractors such as the Protective Materials Company have developed a number of upgrade service programs which can be quickly installed on the vehicle to improve survivability.

The spall suppressant liner can be installed in-country in less than 50 man hours per vehicle with the only special tools required consisting of Mig welder, magnetic drill press with positioners and special drill templates.

The spall suppressant liner adds 414 kg to the total weight of the vehicle. The liners on either side of the troop compartment are on runners to allow access to the gap between the liner and the aluminium hull side which is used for stowage. A suppressant liner is also provided on the roof and rear ramp.

According to the manufacturer, this rigid formed composite armour panel represents a low cost lightweight method of improving troop survivability without adversely affecting the available crew and cargo space.

On current production M113A3s the fuel tanks have been repositioned to either side of the rear ramp from the inside of the vehicle. This has both increased survivability as well as increasing the amount of stowage space available in the vehicle. FMC can provide the fuel tanks to be retrofitted to earlier vehicles. The fuel tanks provide the same degree of ballistic protection as the hull, retain 360 litre diesel fuel capacity, can be rapidly replaced in the field if damaged and are identical and interchangeable. Automatic fuel control permits vehicle operation if one fuel tank is damaged.

Status: In production. In service with the US Army.



One of several mounting configurations for Protective Materials spall shield armour in FMC M113 series APC

Manufacturer: Protective Materials Company, 51 Monroe Street, Rockville, Maryland 20850, USA

Smoke Dischargers, Grenades and Decoys

ARGENTINA

DGFM 76 mm Grenade Launching System

Development/Description

This 76 mm grenade launching system is installed on the Argentinian TAM medium tank and VCTP infantry combat vehicle. In the case of the former a bank of four grenade launchers is mounted either side of the turret while in the case of the latter a bank of four smoke dischargers is mounted either side of the hull. In both cases they fire forwards.

In addition to the bank of four grenade launchers, banks of three and six launchers are also available. The grenades are launched electrically and have a maximum range of 40 to 60 m. The smoke cloud lasts about three minutes with the smoke duration depending on the number of launching tubes utilised.

Status: Production as required. In service with the Argentinian Army.

Manufacturer: Direccion General de Fabricaciones Militares, Cabildo 65, Buenos Aires, Argentina.



Argentinian TAM medium tank with bank of four electrically operated smoke dischargers on turret side

COMMONWEALTH OF INDEPENDENT STATES

Commonwealth of Independent States Smoke Systems

Development/Description

Since the Second World War almost every former Soviet full tracked armoured vehicle, including the T-54, T-55, T-62, T-64, T-72 and T-80 MBTs, has had the capability of injecting diesel fuel into its exhaust system to lay a smoke screen. With the exception of the T-80, the exhaust outlet is on the left side of the hull towards the rear.

More recently, however, many vehicles, tracked and wheeled, have been fitted with 81 mm smoke dischargers as well as fire to the frontal arc.

Typical examples are:

Vehicle

T-80U MBT T-72 (not all models)

T-64 (not all models) BMP-2 IFV BMP-3 ICV BTR-80 (8 × 8) APC

Smoke Dischargers

4 either side of turret 7 on left and 5 on right side of turret

6 either side of turret

3 either side of turret 3 either side of turret

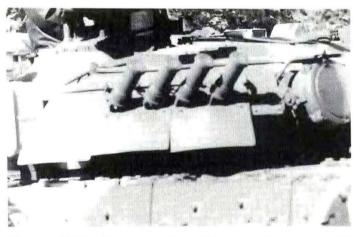
6 mounted on turret rear

Status: Production. In service with the CIS and countries which have received aid from the CIS or the former Warsaw Pact.

Manufacturer: Former Soviet state factories.



T-62 MBT laying a smoke screen by injecting diesel fuel in the exhaust outlet on the left side of the hull



Close up of T-80U MBT showing 4 forward firing smoke dischargers on side of turret

Drozd (Thrush) Dynamic Defence System

Development/Description

The Drozd (Thrush) dynamic defence system is believed to have been developed in the former Soviet Union in the late 1970's and was first fitted to T-55 MBTs in the late 1980's. These upgraded vehicles are designed the T-55AD

The Drozd (Thrush) system consists of a pair of Millimetre Wave (MMW) sensors mounted on either side of the tank turret below which is a pair of quadruple rocket launchers so angled to cover the frontal arc.

These early MMW sensors are gated to acquire incoming objects such as anti-tank guided weapons and filter out other objects such as helicopters and bullets.

When an incoming anti-tank guided weapon is acquired, one or more of the rocket launchers is fired. The rocket contains a fragmentation warhead that disperses a small cloud of steel pellets in front of the incoming anti-tank guided weapon. This should prematurely detonate the warhead or cause the missile to crash before it hits the MBT.

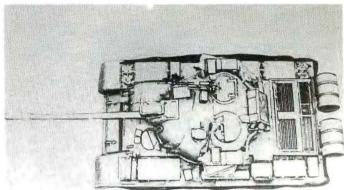
Under the Coventional Forces Europe treaty, the former Soviet Union declared around 250 T-55AD vehicles late in 1990, all of which were located in the European USSR.

It is understood that this system was very expensive and was therefore only installed on the T-55 MBT. No effort appears to have been made to install this on the T-64, T-72 or T-80 MBTs.

Status: Production complete. May still be in limited service with the Commonwealth of Independent States.

Manufacturer: Former Soviet state factories.





T-55AD Drozd (Thrush) MBT

T-55AD Drozd (Thrush) MBT

EGYPT

Kader 76 mm Smoke Grenade Launcher System

Development/Description

The Kader 76 mm smoke grenade launcher system has been developed by the Kader Factory for Developed Industries for installation on all types of tanks, armoured personnel carriers, reconnaissance vehicles and selfpropelled artillery systems.

Although its primary function is to establish quickly a smoke screen to enable a vehicle to change its position, it can also fire phosphorous, illuminating, tear gas (CS) or decoy flares.

The system consists of eight launchers mounted four either side of the vehicle or turret and these can be fired by the commander, driver or gunner in an individual mode or in a number of sequences. For example they can be fired one by one or in salvo; four left; four right or eight in salvo. The launchers are elevated at an angle of 45° to give the maximum range and installed at traverse angles of 4 to 30° to cover the maximum frontal arc of the vehicle.

The position of the control box depends on the vehicle application, for example, in the Kader Fahd (4 \times 4) APC the swivelling control box is located between the commander and driver so that either crew member can operate the system. The control box also enables the operator to verify the loading of the individual tubes with grenades and their reliability to be fired.

The individual firing push-buttons illuminate just after the loading of the tubes with new grenades and an unloaded tube or a tube with a defective grenade will not cause the push-button to illuminate. After firing the light goes out.

The smoke screen starts to form almost immediately the grenades have landed and a salvo of eight grenades lasts for a period of two to three minutes at a range of 50 to 60 m, to a height of 15 m, a depth of 30 m and a total front of between 60 and 70 m.

The top of each grenade launcher is normally covered by a rubber cap that is attached to the launcher by a chain. The tubes can be opened from underneath to allow them to be cleaned by a special brush after firing. The rubber caps protect the launcher against dust, moisture and other environmental conditions.

SPECIFICATIONS

CALIBRE NUMBER OF LAUNCHER TUBES 76 mm

8

OPERATING VOLTAGE 24 V TEMPERATURE RANGE $-20 \text{ to } +63^{\circ}\text{C}$ HUMIDITY 95% at 55°C VIBRATION up to 500 Hz at 2 g

Status: In production. In service with the Egyptian Army and in other undisclosed countries.

Manufacturer: Kader Factory for Developed Industries, Orouba Street, Heliopolis, POB 267, Arab Republic of Egypt. Telephone: 611142; 604324 Telex: 22651 KADFA UN Fax: 2608718



Kader Fahd 30 (4 \times 4) APC with bank of four electrically operated smoke dischargers firing forward mounted on either side of the hull. The turret of the Fahd 30 is identical to that of the former Soviet BMP-2 infantry fighting vehicle

Kaha Type 270/M239 66 mm Smoke Grenade Launcher

Development/Description

Each Type 270/M239 system consists of a bank of six 66 mm launcher tubes all at a different angle, which are used to project a smoke grenade to a range of 30 to 40 m over the frontal arc of the vehicle.

A complete system consists of two launchers, two grenade stowage bins, two canvas covers which are used when the grenade launchers are not in

use and one electrical operating unit which is installed inside the vehicle, normally at the commander's station.

SPECIFICATIONS

 Status: Production as required. In service with the Egyptian Army.

Manufacturer: Kaha Company for Chemical Industries, PO Box 2332, Cairo, Arab Republic of Egypt.



Egyptian T-55 MBT with 105 mm gun showing bank of six 66 mm Kaha Type 270/M239 smoke grenade launchers either side of main armament (Christopher F Foss)

Kaha Screen Smoke Grenades

66 mm Smoke Screening Grenade

This grenade is fired from a 66 mm smoke grenade launcher such as the Kaha Type 270/M239 system described in the previous entry. The grenade is electrically fired and produces a smoke screen 30 m wide lasting for a period of 90 seconds, although this does depend on the weather conditions.

The grenade consists of a metal housing containing the propelling charge and fuze and a black rubber case filled with a pellet of red phosphorus mixture which, when ignited, bursts the case and produces an immediate cloud of smoke in front of the vehicle.

76 mm Smoke Screening Grenade

This grenade is fired from a 76 mm launcher such as that produced by the Kader Factory for Developed Industries. Like the 66 mm smoke screening grenade it is electrically fired and produces a cloud of smoke in front of the vehicle.

SPECIFICATIONS

CALIBRE	66 mm	76 mm
RANGE	25 m	55 m
MAX DELAY TIME	1.1 s	5 s
HEIGHT OF BURST	7 m	n/av
WEIGHT OF MAIN FILLING	360 g	n/av
SCREEN WIDTH	30 m	n/av
DURATION OF SMOKE	1.5 m	2 m
OPERATING VOLTAGE	3 V	3 V
LENGTH	185 mm	158 mm

Status: Production as required. In service with the Egyptian Army.

Manufacturer: Kaha Company for Chemical Industries, PO Box 2332, Cairo, Arab Republic of Egypt.

FRANCE

GALIX Combat Vehicle Protection System

Development/Description

The GALIX self-defence system for combat vehicles has been developed by Etienne Lacroix and Giat Industries for installation on a wide range of combat vehicles, tracked and wheeled. Its first new production application is the Giat Industries Leclerc MBT, the first production example of which was delivered to the French Army in January 1992.

GALIX is a self-contained modular system that can be fitted easily to virtually any vehicle.

The launch tubes can accommodate an extended range of ammunition so that defence can be adapted to the specific operational requirements.

The different grenades are fired on a flat trajectory to give an almost immediate response with the ammunition and submunition design giving an excellent effect pattern on the ground.

The 80 mm calibre grenades, combined with the latest pyrotechnics and technology, are claimed by the manufacturers to give a much improved performance over existing systems.

GALIX operates independently of the vehicles main and secondary armament and future developments are already underway to extend the capabilities of the system to take into account future threats.

The three key components of the GALIX system are the firing unit, launcher and ammunition.

The firing unit is located inside the vehicle and connected independently to the onboard power supply and enables the vehicle commander to fire the selected GALIX ammunition without committing his main or secondary armament. The firing unit has a built in test system and the tank commander can select the number of grenades to be fired.

The number of launchers depends on the type of vehicle and they are arranged and orientated on the turret or chassis. The grenade launchers are loaded with ammunition appropriate to the requirement of the particular mission being undertaken.

The launcher has a bayonet type lock for the grenades with electrical contact by a central stud that is insensitive to water and humidity. Each launcher tube weighs 3.9 kg and is at an angle of 11° in elevation. Once a grenade has been fired, the launcher can be immediately reloaded.

The GALIX system can fire a wide range of grenades to defend the vehicle against different threats and these include smoke, anti-personnel, flare, tear gas and decoy.

SPECIFICATIONS

ì	r	e	n	a	d	e	S	
		_		_	_	_	_	

Type	FUM	AP	FUM LB	ECL	LEUR	LACRY
HEIGHT	361 mm	250 mm	400 mm	500 mm	300 mm	274 mm
WEIGHT	4.9 kg	3.6 kg	5.1 kg	4.8 kg	2.4 kg	1.7 kg

FUM = smoke
AP = anti-personnel
FUM LB = multi-band screening smoke
ECL = flare
LEUR = decoy
LACRY = tear gas

Status: In production for the French Army.



Giat Industries Leclerc MBT is fitted with the GALIX combat vehicle protection system with the launchers being installed in the upper part of the turret towards the rear

Manufacturers: Giat Industries, 13 route de la Minière, F-78034 Versailles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

Etienne Lacroix, Factory and Management, 6 boulevard de Joffrery, F-3600 Muret Cedex, France.

Telephone: 61 56 65 00 Telex: 531 478 F LACART Fax: 61 51 42 77

Giat Industries 80 mm Smoke Canisters

Development/Description

The Giat Industries AMX-30 and AMX-30 B2 are normally fitted with four electrically operated 80 mm smoke dischargers on their turrets, two on either side. Armoured personnel carriers also have four electrically operated smoke dischargers; in the case of the AMX-10P these are mounted two either side at the hull rear. In all cases the smoke dischargers are angled to fire forwards over the front of the vehicle.



These smoke dischargers fire the standard 80 mm smoke screen canister, designated the ARF FUM F1. More recently Giat Industries has developed the ARF FUM VIR G2 grenade which is effective in both the visible range and infra-red range.

Both grenades are electrically ignited and are supplied in cases of eight canisters.

SPECIFICATIONS		
MODEL	ARF FUM 80 F1	ARF FUM 80 VIR G2
OVERALL LENGTH	290 mm	290 mm
DIAMETER	80 mm	80 mm
TOTAL WEIGHT	3.1 kg	2.4 kg
CONTENT WEIGHT	2 kg	1.4 kg
TIME OF SMOKE DISCHARGE	40 s	20 s
DISTANCE THROWN BY		
LAUNCHER	40 m	40 m
STARTING TIME	5 to 8 s	5 s
SPECTRAL RANGE	0.4 to 0.9 µm	0.4 to 14 µm

Status: ARF FUM 80 F1 is in production. In service with the French and many other armies. ARF FUM VIR G2 development complete. Ready for production.

Manufacturer: Giat Industries, 13 route de la Minière, F-78034 Versailles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

Giat Industries AMX-30 MBT B2 showing bank of two electrically operated Giat Industries smoke dischargers to right of turret bustle (C R Zwart)

Ruggieri Spider Close-in Vehicle Defence System

Development/Description

The Ruggieri Spider close-in vehicle defence system has been designed to provide close-in defence protection for combat vehicles against personnel and light armoured vehicles. The role of the system depends on the type of munition used.

The system consists of a number of launcher tubes that fire projectiles over a 50 m radius to the sides and rear of a carrier vehicle. Each launcher has two magazine-loaded projectiles that are launched to variable ranges of 11, 22, 33 or 44 m and the system is arranged so that all the projectiles detonate simultaneously. The arc of fire can be prearranged by an onboard control unit and it is possible to fire all the launcher tubes at once. The launchers may be fitted in groups on a turret or on the hull. The actual number of launchers can vary from vehicle to vehicle but the usual number is 8, 12 or 16.

Each prepacked magazine contains two projectiles, each with a variable warhead range. Each 40 mm projectile has a base which provides spin stabilisation and rotates to determine the time of flight for detonation. There is also a mechanical safety device which places the pyrotechnic train into alignment only after the acceleration produced by firing. The RDX warhead is surrounded by approximately 900 preformed steel ball fragments, each weighing 175 g.



Ruggieri Spider close-in vehicle protection system on VAB (6 \times 6) APC



Ruggieri Spider close-in vehicle defence system with controls in right foreground

SPECIFICATIONS

Spider launcher system

Modular protection

Delay 1.5 s

Launcher integrity ensured by control of fragmentation burst

Number of launchers, 4 to 16 per vehicle

Weight, 40 to 150 kg

Protection arc, 240° (5500 m²) or 360° (7700 m²)

Spider ammunition

CAPIRO 50

2 sub-projectiles per cartridge

900 spherical fragments per projectile

Initial speed 800 m/s

Will perforate 7 mm of aluminium 20 m from explosion point Weight of cartridge 1.5 kg

SOUND

Same ballistics as CAPIRO 50

Sound intensity, 160 dB 40 m from explosion point

190 SMOKE DISCHARGERS, GRENADES AND DECOYS / France - Germany

SEPF1

Instantaneous masking in visible range Cloud forms 15 to 35 m from vehicle Delay 5 s Cloud duration 30 s Weight 2 kg

Status: Qualification trials.

SEPIA

Masking in visible and infra-red range Delay 2 s Non-toxic Duration 30 s with wind speed of 4 m/s Weight 2.3 kg

Manufacturer: Ruggieri, 86, avenue de Saint-Ouen, F-75018 Paris, France Telephone: (1) 46 27 12 08 Telex: 283 581 F Fax: (1) 42 26 66 65

GERMANY

Buck Self-Protection System

Development/Description

Buck has been engaged in the design, development and production of smoke and other screening grenades for many years and in 1990 was awarded a contract from the German Army for the development of a new defensive infra-red screening smoke device for the Gepard twin 35 mm self-propelled anti-aircraft gun system and the Roland self-propelled surface-to-air missile system.

Trials of this new Self-Protection System (SPS) are expected to be carried out in 1993 with vehicle installation following from 1994. Late in 1992, however, the German MoD cancelled the extensive upgrade plans

for these two vehicles so the future of this SPS is not certain at the present time.

The new Buck Self Protection System can fire four salvos of infra-red screening smoke as opposed to just one with the current systems fitted to the Gepard and Roland vehicles.

It is possible that the whole of the German Army fleet, tracked and wheeled, will be upgraded with this system in the future, funding permitting. In addition, Buck has developed a new 76 mm smoke grenade which can be fired from the launcher fitted to existing MBTs such as the Leopard 2.

In 1992 the company also showed its new Multiple Launcher Dispenser System (MLDS). In a typical land application this could be mounted on a trailer towed by a truck and be used for offensive/defensive purposes.

Status: The Self-Protection System is under development for the German Army.

Manufacturer: Buck Werke GmbH and Co, Technologiezentrum, D-8230 Bad Reichenhall – Fronau, Federal Republic of Germany.
Telephone: 08651 702-0 Telex: 17-865 1801 Fax: 08651 702-70



The Buck Multiple Launch Dispenser in trailer-mounted configuration



Model of Gepard twin 35 mm self-propelled anti-aircraft gun system with Buck Self-Protection System installed on forward part of turret firing over frontal arc

Wegmann 76 mm Multi-Purpose Grenade Launcher System

Description

This system can be employed independently of the other weapons on the vehicle and can be mounted as additional equipment on all armoured vehicles (battle tanks, APCs, recovery vehicles and so on).

The function of the system is to set up a smoke screen at a certain distance from the vehicle which then can change position without being seen by the enemy. In addition to visible and IR smoke it is also possible to fire HE fragmentation and tear gas grenades.

The launcher system consists of a number of single launcher units mounted externally on the armoured vehicle, assembled in groups on each vehicle side. The grenades are fired electrically from the control panel inside the vehicle and can be fired in groups or singly, depending on the configuration of the control panel used.

The grenade propellants are ignited electrically and the grenades fired into the target area. The delay expires during flight and the smoke charge is activated and dispersed. An immediate smoke wall results.

The launcher system can also be used on vehicles which are capable of submerged operation. It is a standard supply item of all German armoured vehicles and of other armed forces.

Developed from the smoke and tear gas launcher system, the smoke and fragmentation grenade launchers can be used to deflect enemy personnel in the immediate area of the armoured vehicle whose remaining armament is not able to cover the close-in range up to 50 m. The system can also be used against personnel in covered positions and behind embankments.

In general the smoke and fragmentation launcher system is placed in the same way as the smoke and tear-gas launchers on the outside of an armoured vehicle. For example two groups, each consisting of six launchers, fixed on the turret, can be installed on the Cadillac Gage Textron Commando V-150 Armoured Vehicle Range. This mounting in connection with a special control device enables the simultaneous launching of three smoke or tear-gas grenades per group and the single launching of fragmentation grenades.

Other data for the launcher are comparable to the smoke grenade launcher system data.

DISPERSION OF SMOKE

WALL* 150 m wide, 20 m high, 30 m

deep

TEMPERATURE RANGE -35 to +63°C

NB: other types of grenade are available

 * 0.5 seconds after burst when eight grenades are fired in salvo – wind velocity 3-5 m/s

Launcher Unit

CALIBRE 76 mm
LAUNCH ANGLE 45° elevation
RATED VOLTAGE 24 V

Fragmentation Grenade (qv)

 CALIBRE
 76 mm

 WEIGHT
 1.7 kg

 WARHEAD STEEL FRAGMENTS
 2800 steel balls

Status: In production. In service with German armed forces and various

other armies.



Leopard 2 MBT of German Army showing two banks of eight Wegmann 76 mm multipurpose grenade launchers on side of turret

Manufacturer: Wegmann and Co GmbH, August-Bode-Strasse 1, D-3500 Kassel, Federal Republic of Germany.

Telephone: 0561 1050 Telex: 99859 Fax: 0561 105 2208

Wegmann 76 mm Adjustable Launcher System

Description

Intended for fitting to any type of armoured vehicle, the Wegmann 76 mm grenade launcher system can be rotated through a full 360° to provide grenade coverage to any sector around the vehicle. It has a single launcher barrel which is normally mounted at an angle of 45°, although other angles can be selected. The launcher tube is mounted on a steel turntable, in the centre of which is the loading hatch. To reload the launcher the hatch is opened downwards from within the vehicle and a grenade inserted. As the hatch is closed it positions the launcher at the correct angle; a safety interlock prevents firing if the hatch is not properly closed. An indicator inside the turntable provides the operator with the direction in which the launcher is pointing. Firing is electrical from a control box inside the vehicle. Grenades used may be smoke, tear gas and in a special version HE.

A completely waterproof version for use with amphibious vehicles is available. Each launcher is provided with test equipment, a cleaning brush and a small pouch with spare parts.

SPECIFICATIONS

CALIBRE 76 mm
WEIGHT .
steel turntable 22 kg approx

launcher assembly 15 kg approx FIRING ANGLE 45° TRAVERSE 360°

Status: In production. By early 1993 some 300 of these systems had been produced.

Manufacturer: Wegmann and Co GmbH, August-Bode-Strasse 1, D-3500 Kassel, Federal Republic of Germany.

Telephone: 0561 1050 Telex: 99859 Fax: 0561 105 2208



Wegmann 76 mm adjustable launcher system

Diehl 76 mm Vehicle Fragmentation Grenade

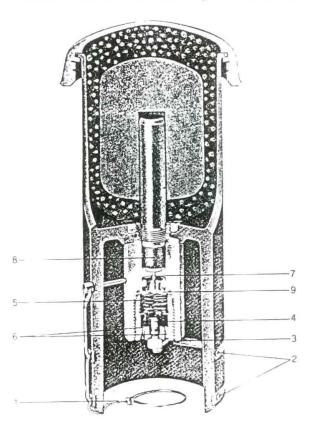
Development/Description

The 76 mm vehicle fragmentation grenade has been designed to be fired from the 76 mm smoke discharger designed by Wegmann of Kassel (qv) and installed on most AFVs of the German Army including the Leopard 2 MBT (four launchers), Leopard 1 MBT (two launchers), Gepard self-propelled anti-aircraft gun system (two launchers), M109 series 155 mm self-propelled howitzer (two launchers) and the Transportpanzer 1 (one six round launcher).

The grenade functions as follows: before loading the safety pin (1) is removed. When the system is operated from the turret ignition, current from an electrical firing unit flows via contact rings (2) and cable (3) to the igniter cap (4), which then ignites the propellant (5). The gas pressure generated by the combustion of the propellant expands through the gas ports (6) into the remaining space in the launcher, accelerating the grenade to a velocity of about 24 m/s. The initial pressure generated by the propellant shears off a collar (9) on the striker (7) which then activates the fuze (8) and ignites the cap in the pyrotechnic time fuze, which initiates the explosive charge after a flight time of 1.8 seconds and 3.8 seconds respectively. Launched at an angle of 63° the grenade has a range of between 40 and 45 m. The

fragmentation warhead contains preformed balls in order to obtain a well-defined radius of fragments.

SPECIFICATIONS DESIGNATION M-DN 21 M-DN 31 LAUNCHING ANGLE 45 63 76 mm CALIBRE 76 mm 1.7 kg WEIGHT 1.7 kg 200 mm LENGTH 200 mm NO OF STEEL FRAGMENTS 2800 2800 EXPLOSIVE WEIGHT 270 g 270 g 1.2 g PROPELLANT WEIGHT (approx) 1,2 g ARMING DISTANCE (approx) 2.5 s 1.9 s DESTRUCTION TIME (approx) 3.8 s2.8 s VELOCITY (approx) 24 m/s 24 m/s DETONATION ABOVE GROUND (approx) 10 m 10 m BURSTING DISTANCE (approx) 45 m 45 m



Status: In production. In service with many countries.

Manufacturer: Diehl-Wehrtechnik, D-8505 Röthenbach, Fischbachstrasse

20, Federal Republic of Germany.

Telephone: 0911 509-1 Telex: 622591-44 MD D

Diehl 76 mm fragmentation grenade

NICO Pyrotechnik Vehicle Grenades

Development/Description

NICO Pyrotechnik manufactures a wide range of screening and signalling devices for various applications, including vehicle-mounted launching systems, with calibres of 40, 66, 76 and 81 mm.

NICO NT screening smoke

This is a plastic bonded pyrotechnic smoke composition that does not contain either HC or metal powders and gives a pure white colour. The smoke consists of ammonia-complexed zinc chloride, ammonium chloride and water and when burnt leaves only a residue of 1 to 3 per cent by weight. There is no screening effect above the 1 µm wavelength.

NICO IR smoke

This is designated the NS 20 and is efficient in the $3-5~\mu m$ and $8-14~\mu m$ regions. It cannot be penetrated by a laser rangefinder and is capable of developing in IR screen 25 to 40 m from the launcher in one second. It is claimed to be more difficult to detect on the battlefield because of its colour and its temperature.

NICO HC smoke

Hexachlorethane (HC) developes a very dense screening smoke, greyish in colour, under most climatic conditions.

NICO KM screening smoke

This was launched in 1990 and is a non-toxic smoke consisting of a pyrotechnically generated aerosol, the main ingredients of which are potassium chloride and magnesium oxide. These produce a smoke of pure white colour. The KM screening smoke can be used as a substitute for HC and NT grenades for training purposes.

SPECIFICATIONS				
Туре	NT	KM	IR	HC
CALIBRE	76 mm	76 mm	76 mm	76 mm
LENGTH	168 mm	168 mm	168 mm	168 mm
WEIGHT	1.3 kg	1.25 kg	1.95 kg	1.45 kg
FIRING ANGLE	45°/20°	45°/20°	45°	45°/20°
RANGE	40 m	40 m	30 m	40 m
BURNING TIME	100 s	80 s	-	120 s
DELAY TIME	0.5 s	0.5 s	2 s	0.5 s

Status: Production as required. In service with various countries.

Manufacturer: NICO Pyrotechnik, Hanns-Jurgen Diederichs GmbH & Co KG, Bei der Feuerwerkerei 4, Postfach 1227, D-2077 Trittau, Federal Republic of Germany.

Telephone: 041 54 80 50 Telex: 2189413 nico d Fax: 041 54 24 51



NICO 76 mm smoke grenades for vehicle launchers, from left to right Types NT, IR and HC

GREECE

PYRKAL GRL-76-10 76 mm Tank Close Defence System

Development/Description

This system has been designed for installation on a wide range of armoured vehicles including tanks, reconnaissance vehicles, self-propelled guns and howitzers and warships. The 76 in the system designation relates to the calibre of the launcher, while the 10 relates to the number of launchers.

The system consists of two banks of five 76 mm launchers that are normally mounted five on either side of the turret and fire forwards with the operator's panel being inside the vehicle, normally at the commander's station.

All parts of the system are fully waterproof with most parts being interchangeable. All parts are made of high grade steel for low vulnerability to small arms fire and shrapnel.

The grenades are electrically fired with the operator being able to select coverage. The capability of altering the launcher tubes in azimuth is also provided.

The operators panel has an on/off switch, full coverage button, and four buttons, positioned on the left side (to launch two grenades), on the front right (to launch two grenades), and on the centre left and centre right (to launch three grenades each).

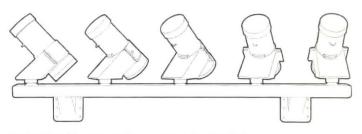
The coverage arc is through 205 $^\circ$ with grenades covering a 50 $^\circ$ arc. Typically, each grenade lands about 60 m from the vehicle and covers a circle with a radius of 15 m.

It launches all types of 76 mm close defence ammunition including smoke grenade RP, smoke grenade HC, smoke grenade IR screening, chaff dispersing grenade, flare grenade and anti-personnel grenade.

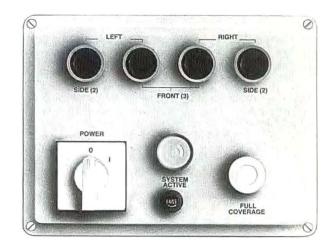
Status: Production.

Manufacturer: Greek Powder & Cartridge Company (PYRKAL). 1 Ilioupoleos Avenue, GR-172 36 Hymettus, Athens, Greece.

Telephone: (1) 9751 857 Telex: 22 1986 EEPK GR Fax: (1) 9505 009



Bank of five 76 mm launchers on mounting bracket



Close-up of operator's panel of PYRKAL GRL-76-10 tank close defence system

ISRAEL

RAFAEL Screen Obscurant Smoke System

Development/Description

The Screen battlefield obscurant smoke system has been developed by the RAFAEL Armament Development Authority to provide a rapid smoke screening capability to field units.

Screen consists of the multiple rocket launcher, fire-control unit and finstabilised smoke rounds. The launcher can be mounted on the rear of any MBT and carries 20 smoke rounds in three layers.

Once loaded the system is operated from within the tank and the operator can select one of two modes, single shot or semi-automatic. Range is from 750 to 1500 m, achieved by elevating the launcher.

When the whole salvo of 20 rocket rounds are fired, a smoke screen approximately 2000 m wide is formed which lasts about 10 minutes. According to RAFAEL, Screen is wind insensitive.

Status: Development complete. Ready for production.

Manufacturer: RAFAEL Armament Development Authority, PO Box 2082, IL-31021 Haifa, Israel.

Telephone: (04) 776965 Telex: 471508 VERED IL Fax: (04) 794657



RAFAEL Screen obscurant smoke system being loaded

TAAS – Israel Industries CL-3030 Instantaneous Self-Screening System For Combat Vehicles

Development/Description

The CL-3030 instantaneous self-screening system for combat vehicles has been developed by TAAS – Israel Industries to meet the requirements of the Israeli Army. It is in service mounted either side of the main armament of vehicles such as the Merkava Mk 3, M48, M60 and Centurion MBTs.

The TAAS - Israel Industries CL-3030 instantaneous self-screening system for combat vehicles is a key part of the POMALS covered in the following entry.

The basic components of the system are two launch containers which are mounted one each side of the tank's main gun and point forward. Depending on the basic system used, IS-6 or IS-10, the containers hold one or two cassettes, with six or 10 smoke shells.

At the tank commander's discretion two smoke shells are launched simultaneously, one from each of the launch containers, creating in less than two seconds a smoke screen which effectively conceals the tank. Under average wind conditions, the screen lasts between one and two minutes, giving the tank time to move its position. The location of the screen is determined by rotating the turret to the desired direction before firing.

The screen is created at a distance of 40 to 50 m from the tank and is initially 60 m wide and 4 to 8 m high. Angle of concealment is about 70° growing afterwards in the direction in which the wind is blowing.

There are two basic systems for tanks and other vehicles with a turret. These are the IS-6 system with two launch containers, each holding a single cassette with six smoke shells, and the IS-10 system with two launch containers each holding two cassettes with five smoke shells in each.

The IS-10 system allows 10 screening operations to be carried out without reloading. The IS-6 system enables the tank commander to fire six pairs of shells for six separate screening operations.

IS-10 system

The IS-10 launch container houses 10 smoke shells in two cassettes of five shells each. The cassettes are loaded by hand into the launch container and locked into place by handles at the top and bottom of each cassette. Loading takes a few seconds and the cassettes are quickly removable for easy cleaning and maintenance. Extensive testing has shown that 25 rounds can be fired from a launching tube within the cassette before cleaning is indicated.

The smoke shells are loaded into the launching tubes in the empty cassettes, locked into the launch container. They are pushed in and lock into the tube by means of a spring catch, and can be removed by a pull ring

on the head of the shell. Once in the container, the shells are protected against small arms fire and artillery fragments by 12.5 mm of steel armour plate. The only exposed part of the shell, the head, is protected by an armoured cap. The launch container has a built-in electromechanical selector which automatically determines the sequence of the shells launched. At the same time, it shorts out the firing circuit until the firing impulse is received from the control unit inside the tank.

The control unit is a switch box, activated by the tank commander and reset by a simple switch after reloading. The launch container of the IS-10 system is mounted on the tank by bolts; this can be accomplished at field level.

IS-6 system

This is similar in operation to the IS-10 system, with the difference that the IS-6 launch container holds one cassette with six smoke shells. The cassette is locked into place by a handle on the container itself. The container is mounted on the tank, by means of a steel bracket, at field level, and shells within are protected by 8 mm of impact resistant steel plate.

Other systems

In addition to the IS-6 and IS-10 systems, for tanks and vehicles with a turret, the CL-3030 system is available in a wide variety of configurations for use on APCs and armoured fighting vehicles without turret. As a general practice four to six five-shell cassettes are mounted on the vehicle in different places by means of a mounting base instead of a launch container, thus providing smoke screen protection in all directions.

Smoke shell

The smoke shell contains approximately 850 g of a specially modified red phosphorous smoke-producing material. The smoke is non-toxic.

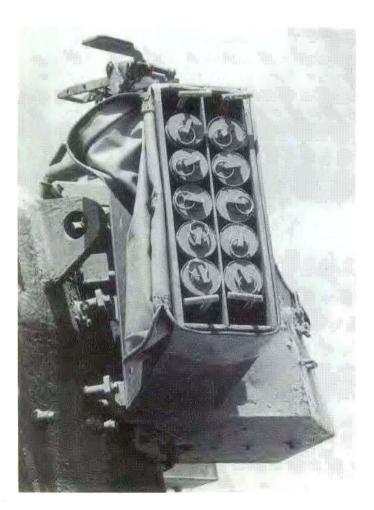
On launching the smoke shell, part of the material ignites in the air, creating the initial smoke cloud. The rest is dispersed over the ground in the form of small, smoking particles which continue to burn, replenishing and reinforcing the smoke screen and keeping it going for one to two minutes so allowing the tank to move out of sight.

The shell is fired by a low-sensitivity 1 A/1 W, no-fire squib. It is equipped with a device which shorts out the squib until the shell is locked into the cassette. Once in the cassette, the squib is kept shorted out by the internal circuitry of the container itself until the firing pulse is supplied from the control unit inside the tank.

The squib is mounted in a conductive Faraday cage which isolates it from external radio frequency sources.

SPECIFICATIONS

Smoke shell





Close-up of IS-10 launcher system installed on Centurion MBT

Close-up of IS-6 launcher system

IS-10 system

LAUNCH CONTAINER CAPACITY 2 cassettes, 5 tubes each

 WEIGHT UNLOADED
 60 kg

 HEIGHT
 531 mm

 WIDTH
 200 mm

 DEPTH
 406 mm

 STEEL ARMOUR PLATE
 12.5 mm

 MOUNTING
 bolts

 CASSETTE CAPACITY
 5 smoke shells

WEIGHT UNLOADED 17 kg

Status: In production. In service with the Israeli Defence Force.

IS-6 system

LAUNCH CONTAINER CAPACITY 1 cassette, 6 tubes

WEIGHT UNLOADED 33 kg HEIGHT 270 mm WIDTH 186 mm DEPTH 416 mm IMPACT-RESISTANT STEEL PLATE 8 mm MOUNTING steel bracket CASSETTE CAPACITY 6 smoke shells WEIGHT UNLOADED 15 ka

Manufacturer: TAAS - Israel Industries Limited, Weapons Group, PO Box

1044, IL-47100 Ramat Hasharon, Israel.

Telephone: (972) 3 5455370 Fax: (972) 3 6959906

TAAS – Pedestal Operated Multi-Ammunition Launching System (POMALS)

Development/Description

The Pedestal Operated Multi-Ammunition Launching System (POMALS) has been developed as a private venture by TAAS – Israel Industries Limited (previously Israel Military Industries) as a private venture and can be installed on MBT's and other AFV's to improve their battlefield suvivability.

An MBT would typically have two POMALS systems mounted each side of the turret to give coverage to the front and sides of the vehicle.

POMALS is slaved to an automatic detection system which spots incoming radiation emitted by laser rangefinders, laser designators or infra-red sources. POMALS can also be slaved to automatic detectors designed for ultraviolet (UV) radar or other electromagnetic (EM) radiation.

When a signal is detected, the POMALS instantly responds by launching smoke grenades, chaff and flares, decoys, anti-personnel grenades, high explosive grenades or other special munitions.

A typical POMALS would include the power operated pedestal which can traverse through 220° (110° left and 110° right) with its ammunition launcher, control box mounted inside the turret, electrical system, and the LWS-2 laser warning system which is already installed on late production Merkava MBTs and for which there is a separate entry in the Laser Detectors section.

The basic launcher contains 16 launching tubes with up to 20° dispersion but smaller customised launchers can be fitted if required, for example the IS-6 launcher system covered in the previous entry.

The control box would normally be mounted at the commander's position. It has a manual override and a 30° step azimuth calibrator. It also provides threat identification, visual directional display of the threat source using a digital and clock type display and an auto alert to the commander and crew.

The LWS-2 immediately signals the control box which initiates pedestal traverse and launches countermeasures towards the laser detected beam.

As an option, the POMALS can be fitted with built-in automatic wind compensation sensor and can be upgraded to include IFF capability, saving ammunition and further enhancing survivability.

SPECIFICATIONS

Pedestal

 EACH UNIT COVERS
 ±110°

 DIRECTIONAL ACCURACY
 ±0.5°

 PAYLOAD
 0.6 kg/m²

 WEIGHT
 45 kg (each)

Ammunition launcher

basic launcher contains 16 launching tubes with up to 20° dispersion, smaller or customised launchers can be installed

Ammunition

smoke grenades which obscure visible spectrum

2 grenades create, in normal conditions, a full screen measuring 60×6 m at a distance of 50 m within 2 s

chaff and flare decoys

high explosive grenades

anti-personnel grenades

special munitions

IR smoke grenades are also available

Status: Development complete. Ready for production.

Manufacturer: TAAS - Israel Industries Limited, Weapons Group, PO Box

1044, IL-47100, Ramat Hasharon, Israel.

Telephone: (972) 3 5455370 Fax: (972) 3 6959906



POMALS installed on MBT fitted with explosive reactive armour with pedestal containing grenades in centre

NORWAY

RAUFOSS Instantaneous Smoke Screening Systems

Development/Description

The Defence Products Division of RAUFOSS A/S manufactures a number of instantaneous smoke systems that are unaffected by ground conditions, have no pillaring effect and are non-toxic.

These include a 76 mm Instantaneous Smoke Grenade which is fired from Wegmann launchers installed on Leopard 1 MBTs of the Norwegian Army, a 40 mm Instantaneous Smoke Screening System, an Instantaneous Smoke Hand Grenade and a 53 mm Instantaneous Smoke Grenade RA 84.

SPECIFICATIONS

76 mm Instantaneous Smoke Grenade

 DELAY
 2.2 s*

 DURATION
 2 mins

 BURSTING HEIGHT
 10 m

 RANGE
 35 m**

- * Delay can be adjusted to specific requirements.
- ** Range can be adjusted.

Qualified for service in Germany and Norway.

196 SMOKE DISCHARGERS, GRENADES AND DECOYS / Norway - Sweden

53 mm Instantaneous Smoke Grenade

DELAY 1.2 s

DURATION depends on weather

HEIGHT 8 m BANGE 25 m

Qualified for service in Sweden.

53 mm Instantaneous Hand Grenade

DELAY 1.3 s

DURATION depends on weather

Qualified for service in Sweden and Norway.

40 mm Instantaneous Screening System

DELAY 1 s

DURATION depends on weather

 HEIGHT
 10 m

 RANGE
 40 m

 EXTENT
 80 m

Status: Production as required.

Manufacturer: RAUFOSS A/S, Defence Products Division, N-2831 Raufoss,

Norway

Telephone: (47) 61 52 000 Telex: 71144 RA N Fax: (47) 61 52 754

SOUTH AFRICA

ARMSCOR Vehicle Smoke Concealment System

Development/Description

ARMSCOR has developed an unusual two-stage 81 mm smoke generator system suitable for installation on a wide range of tracked and wheeled armoured vehicles.

The 2.5 kg device is fired from a conventional discharger tube which is normally mounted on the turret of the vehicle, using electrical initiation.

To enable it to remain in the launcher tube for long periods ready for instant use, it has been carefully engineered so as to resist dust, vibration and dampness.

Once fired, the launching charge propels the generator from the launcher and simultaneously ignites a delay element. This allows about three seconds to elapse by which time the generator is nearing the end of its trajectory. At this point the delay fires a detonator which bursts open a primary canister, releasing a red phosphorous composition to give an instant cloud of dense white smoke.

At the same time, a secondary canister, charged with hexachloroethane mixture, is ignited. This continues on the trajectory to land on the ground where it continues to emit smoke for a period of 35 to 50 seconds.

The result is that the primary canister produces an instant smoke cloud and the secondary canister stokes the cloud and maintains the cover for a sufficient length of time to allow either the vehicle to withdraw or the crew to make their escape if the vehicle is immobilised.

Most vehicles have a number of smoke dischargers fixed around the turret and a salvo from these will produce a screen amply sufficient for any evasive manoeuvre to be carried out.

Status: In production. In service with the South African Defence Forces.

Manufacturer: Enquiries to ARMSCOR, Private Bag X337, Pretoria 001, South Africa.

Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635



ARMSCOR 81 mm Smoke Generator

SWEDEN

Bofors 71 mm Combat Vehicle Illuminating System

Development

This has been developed by Bofors for installation on a wide range of tracked and wheeled armoured fighting vehicles and shares a number of common components with the infantry/manportable version.

Description

The combat vehicle version of the 71 mm illuminating system Lyran consists of launcher with connection cable, control unit with firing buttons for two launchers and the mortar flare shells.

The mortar flare shells are in individual plastic containers which can be connected together with the upper container in a pack having a carrying handle.

Typically two launchers are mounted on the vehicle firing forwards with firing taking place via the control unit which is located in the crew compartment of the vehicle. The power supply of 24 V is taken from the electrical system of the vehicle.

In addition to the safe position on the fuze, each mortar flare has settings for 400, 800 and 1300 m range with the launcher set at an elevation of 45°. A range of 1300 m is achieved with an increment and is fired only with the vehicle launcher.

The mortar flare shell comprises a front body section, rear body section and a tail unit. The front body section contains the fuze, the delayed pyrotechnical charge, the separating charge and the flare charge. The flare charge is ignited by the separating charge that is initiated by a primer pellet.

The rear body section contains a parachute which is attached to the flare charge and a propellant charge. The flare shell, which has a burning time of 30 seconds, gives 5 lux illumination over an area with a diameter of more than 600 m.

The same elevation of $+45^{\circ}$ is used when firing at 400, 800 and 1300 m. A longer barrel is available which permits firing at 450, 950 and 1600 m using the same flare shells as for 400, 800 and 1300 m.

At night the elevation takes place with the aid of luminous spirit levels which are mounted on the launcher.

Bofors claim that its flare systems could be used successfully at sea for combating smuggling, illuminating ships illegally releasing oil under cover of darkness, identification and rescue work. The latest version of the combat vehicle launcher can now eject flare ammunition to distances of 450 m, 950 m and 1600 m.



Close-up of Centurion of Swedish Army showing two Bofors Lyran 71 mm illuminating launchers on turret rear

SPECIFICATIONS Control unit

WEIGHT **DIMENSIONS**

1.25 kg

165 × 93 × 83 mm

Mortar flare shell

LENGTH (complete) 340 mm WEIGHT (complete) 1.2 kg

MUZZLE VELOCITY 114 m/s (147 m/s with increment) RANGE 400, 800 and 1300 m (short

barrel) 450, 950 and 1600 m (long barrel)

TIME OF FLIGHT 5.5 s to 400 m (short barrel) or

450 m (long barrel)

11.5 s to 800 m (short barrel) or

950 m (long barrel)

16 s to 1300 m (short barrel) or

1600 m (long barrel)

LUMINOUS INTENSITY mean 600 000 cd

30 s **BURNING TIME**

DESCENDING SPEED 3 m/s TEMPERATURE LIMITS -40 to +60°C

Launcher

WEIGHT 17 kg VOLTAGE 24 V DC **ELEVATION SETTINGS** steps of 5° LENGTH AND WIDTH

OF BASE PLATE 205 × 110 mm

Status: Production as required. In service with Belgium, Finland, Norway. Sweden and Switzerland.

Manufacturer: Bofors AB, S-691 80 Karlskoga, Sweden.

Telephone: (46) 586 81000 Telex: 732100 Fax: (46) 586 58145

UNITED KINGDOM

Haley & Weller Vehicle Grenades

Development/Description

Haley & Weller Limited produce a wide range of 66 mm grenades that are launched from all standard grenade dischargers. These grenades are all rubber bodied

V101 Grenade Discharger Smoke Screening

This discharges screening smoke to conceal the movement of vehicles and troops. The grenade is air burst to ensure a good dispersion of the submunitions regardless of the vehicle attitude. The smoke composition has an extremely low incendiary hazard.

OPERATING VOLTAGE 1.5 V (0.5 A) min RANGE 20-35 m 40 s nominal **DURATION OF SCREEN** LENGTH 185 mm DIAMETER 65.5 mm WEIGHT GROSS 0.55 kg NETT EXPLOSIVE QUANTITY

(NEQ)

OPERATING TEMPERATURE

RANGE -30 to +75°C SHELF LIFE 3 years STANDARD PACKAGING 32 grenades

V112 Grenade Discharger Smoke Screening Sand

This is similar to the V101 but discharges coloured smoke to suit terrain. Its air bursting characteristics ensure good dispersion of the 23 submunitions regardless of the vehicle attitude.

0.35 kg

OPERATING VOLTAGE 1.5 V (0.5 A) min RANGE 20-35 m **BURN TIME** 20-35 s nominal LENGTH 185 mm DIAMETER 65.5 mm **GROSS WEIGHT** 0.485 kg NETT EXPLOSIVE QUANTITY

0.287 kg (NEQ)

OPERATIONAL

TEMPERATURE RANGE -30 to +75°C SHELF LIFE 3 years STANDARD PACKAGING 32 grenades

V121 and V122 Grenade Discharger Irritant CS

These discharge CS smoke for riot control purposes. The V121 has a range of 20 to 35 m and the V122 a range of 60 to 90 m. Air bursting characteristics ensure good dispersion of the 23 submunitions.

OPERATING VOLTAGE	1.5 V (0.5 A) min
RANGE V121	20-35 m
RANGE V122	60-90 m
CS EMISSION TIME	20-35 s
LENGTH	185 mm
DIAMETER	65.5 mm
GROSS WEIGHT	0.528 kg

NETT EXPLOSIVE QUANTITY

(NEQ) 0.287 kg

OPERATIONAL TEMPERATURE

RANGE -30 to +75°C SHELF LIFE 3 years STANDARD PACKAGING 32 grenades

V127 and V128 Grenade Discharger Practice Anti-riot

These are the practice versions of the V121 and V122. The performance is identical to the CS variants, with the CS smoke substituted by a non-irritant

OPERATING VOLTAGE	1.5 V (0.5 A) min
RANGE V127	20-35 m
RANGE V128	60-90 m
BURN TIME	20-35 s
LENGTH	185 mm
DIAMETER	65.5 mm
GROSS WEIGHT	0.57 kg
NETT EXPLOSIVE QUANTITY	

0.28 kg (NFO)

OPERATIONAL TEMPERATURE

RANGE -30 to +75°C SHELFLIFE 3 years STANDARD PACKAGING 32 grenades



Haley & Weller vehicle grenades

198 SMOKE DISCHARGERS, GRENADES AND DECOYS / UK

V130 Grenade Discharger Fragmentation

This grenade air bursts at a range of 90-100 m from the vehicle producing a 360° pattern of low velocity fragments.

OPERATING VOLTAGE 1.5 V (0.5 A) min RANGE 90-100 m LENGTH 185 mm DIAMETER 65.5 mm **GROSS WEIGHT** 1.30 kg NETT EXPLOSIVE QUANTITY

0.51 kg

OPERATIONAL TEMPERATURE RANGE

-30 to +75°C SHELF LIFE 3 years STANDARD PACKAGING 25 grenades

Status: In production. In service with undisclosed countries.

Manufacturer: Haley & Weller Limited, Wilne, Draycott, Derbyshire

DE7 3QJ, UK

Telephone: (0332) 872475 Telex: 378215 HALWEL G

Fax: (0332) 873046

Peak 66 mm Grenade Dischargers

Description

The Peak 66 mm grenade dischargers were first developed in 1970 in conjunction with the then Military Vehicles and Engineering Establishment at Chertsey. Since then over 20 different models have been included in the range. The dischargers are primarily intended for the projection of 66 mm smoke grenades but can also be used to project CS gas or IR screening smoke grenades.

There are five basic models in the Peak range as follows:

No 12 Launcher. A four-barrel unit mounted in pairs on vehicles such as Land Rovers, APCs and light tanks, and providing 180° cover. Fitted to the Scorpion range of vehicles.

No 16 Launcher. A two-barrel unit usually mounted two on each side of a vehicle, making a total of eight barrels. Particularly suited to vehicles where space or profile is limited.

No 18 Launcher. A five-barrel unit intended for use on MBTs. Normally mounted one each side to provide 140° smoke cover. Fitted to the Challenger 1 and 2 and Chieftain MBTs.

No 21 Launcher. A four-barrel unit fully waterproofed and developed for US Army use. Usually mounted one each side to provide 140° smoke cover. No 22 Launcher. A six-barrel unit fully waterproofed and developed to replace older MBT models. Mounted in pairs one each side to provide 140° smoke cover

The above are the main types in use but the following have also been produced:

No 10 Launcher. This was designed for mounting on small low profile vehicles such as Land Rovers and Ferret scout cars and has three tubes. No 11 Launcher. This is an aimable four parallel barrel launcher on a pivoting mount for riot control applications. The barrels may be fired singly or simultaneously.

No 20 Launcher. An alternative to the No 12 launcher.

PK 76. An adaptor unit to convert 76 mm German pattern launchers to fire 66 mm grenades.

Expendable rubber caps are fitted over the barrel ends for weatherproofing and are blown off when the launcher is fired.

There are various types of firing control system to suit any particular requirement and various accessories available, such as a circuit tester for inclusion in the vehicle tool kit and armoured steel boxes to hold a spare salvo of grenades, all of which can be supplied.

These include the RD4510 selector unit which has an eight single shot capability plus the benefit of a salvo option, RD4535 control unit which has a two shot capability (left and right) and also incorporates an arming switch, and the RD2500 control box which has a two shot capability (left and right) and salvo. The RD2100 armoured stowage box is mounted externally on armoured vehicles and holds five grenades; it is used with the No 18 launcher. The RD4457 armoured stowage box holds four grenades and is used in conjunction with Nos 11, 12 or 16 launchers.

SPECIFICATIONS

Model SPACE	No 12	No 16	No 18	No 21	No 22
ENVELOPE	162×349	145×180	154×375	161×300	170×435
	\times 237 mm	× 247* mm	\times 270 $^{\circ}$ mm	\times 240 * mm	× 265* mm
WEIGHT	5 kg	2.7 kg	6.8 kg	5 kg	8.9 kg

denotes protuberance

Status: Production. In service with at least 12 countries, including the United Kingdom and US armed forces, Oman and South Korea. Has been fitted to Challenger 1 and 2 MBTs, Scorpion range, Vickers Valkyr APC, Humber (4 × 4) 'Pig' APC, Vickers GBT 155 SPH, Saracen, Saladin APC GKN AT104/105/FS 100, Warrior MCV, M48 MBT, M41, M113 APC, M2 and M3 Bradley MICV, LAV range, Cadillac Gage range, General Motors (Canada) range, Hotspur armoured cars, Short Shorland, Arrowpointe Dragoon, plus others. By early 1993 Peak Engineering had completed some 10 000 grenade launchers.

Manufacturer: Peak Engineering Company Limited, Masons Road, Stratford-upon-Avon, Warwickshire CV37 9NF, UK.

Telephone: (0789) 200400 Telex: 31627 Fax: (0789) 298364







No 18 launcher

Helio Multipurpose Grenade Discharger Systems

FVG 66

The FVG 66 grenade discharger system is capable of firing all types of 66 mm grenades such as smoke (in two colours), CS gas, HE fragmentation, anti-personnel and infra-red screening smoke.

The discharger barrel is manufactured as a single unit, which allows it to be mounted on a platform, in a multiple configuration, to suit customers' installation requirements.

On a typical APC, four barrels per side of the turret or vehicle is sufficient to generate 180° of windowless screen, whilst an MBT would require five per side to obtain the optimum screen.

The firing of the grenades is operated by either the commander or gunner using a switch box inside the vehicle. The switch box can vary using a simple two push-button box firing left or right salvoes or both together, up to a multi-discharge pattern box capable of firing 16 grenades in various patterns.

Each control box has a unique feature in that the grenades themselves can be tested for electrical continuity when loaded into the discharge

Smoke grenades are usually fired to ranges of 30 to 35 m, CS gas grenades can be fired to 60 to 90 m and an HE fragmentation grenade containing 0.75 kg of steel balls to 100 m; this bursts approximately 6 m above the ground. A green smoke is available for training or camouflage purposes. Using smoke grenades a complete screen can be obtained within two seconds of pressing the firing button.

FVG 76

The FVG 76 grenade discharger system compliments the FVG 66 system and is designed to offer the same flexibility required to meet the needs of customers already using 76 mm systems. The control boxes available with this system are the same as the ones used with the FVG 66.

Status: In production. Several hundred delivered.

Manufacturer: Helio Mirror Company Ltd, Crabtree Manorway South, Belvedere, Kent DA17 6AY, UK.

Telephone: (081) 311 4140 Telex: 8951666 Fax: (081) 311 1004



Four round Helio FVG 66 Grenade Launcher





From top to bottom: FVG 66 multipurpose 66 mm grenade launching system. two push-button, single-barrel fire-control switch box (FVS 10); FVG 66 multipurpose 66 mm grenade launching system, 8-barrel, multi-pattern switch box (FVS 15); FVG 66 multipurpose 66 mm grenade launching system, 16-barrel, multi-pattern switch box (FVS 20)



Helio FVG 76 multipurpose 76 mm grenade launching system

Royal Ordnance Visual and Infra-Red Smoke Screening System

Development/Description

The Visual and Infra-Red Smoke Screening system (VIRSS) has been developed by Royal Ordnance to meet the requirements of the British Army. It has been installed on the Challenger 1 MBT, Warrior mechanised combat vehicle, Fox armoured car, and Scorpion CVR(T) for trials

VIRSS gives the vehicle commander a broadband vehicle screen system effective from visual through to far infra-red spectra, providing protection against thermal imagers and other target acquisition devices.

The VIRSS system uses a regenerative airburst mechanism to replenish the screen constantly by firing successive projectiles. It screens the vehicle in both visual and three to five and eight to $14\,\mu m$ infra-red regions of the electromagnetic spectrum.



Fox armoured car with Royal Ordnance VIRSS launchers on side of turret

200 SMOKE DISCHARGERS, GRENADES AND DECOYS / UK-USA

Royal Ordnance Visual and Infra-Red Screening Smoke

Royal Ordnance has developed a new grenade that has some advantages of VIRSS but can be fired from the standard 66 mm grenade launcher.

These grenades contain a double payload of red phosphorous to provide a visual screen, and a metal flake to defeat infra-red devices.

Status: Development.

Manufacturer: British Aerospace Defence Limited, Royal Ordnance Division, Euxton Lane, Chorley, Lancashire PR7 6AD, UK.

Telephone: (0257) 265511 Telex: 67441 Fax: (0257) 242199

Royal Ordnance L8 Smoke Grenades

Development/Description

The Royal Ordnance L8 smoke grenade is fired from a 66 mm smoke grenade launcher and produces an immediate smoke screen for vehicle protection.

The L8 consists of a metal housing which contains the propelling charge and fuze and a black rubber case filled with a pellet of red phosphorus which, when ignited, bursts the case and produces an immediate cloud of smoke in the form of a curtain in front of the vehicle. The L8 grenade is electrically ignited and the fragments of burning phosphorus fall to the ground and continue to produce smoke. The cover is complete in about two seconds.



SPECIFICATIONS

25 m RANGE TO BURST DELAY TIME 1.05 s HEIGHT OF BURST 6 m WEIGHT OF MAIN FILLING 0.36 kg SCREEN WIDTH 35 m (approx) DURATION OF SMOKE CLOUD 1 min minimum* WEIGHT COMPLETE 0.68 kg LENGTH 185 mm DIAMETER 66 mm **OPERATING VOLTAGE** 24 V

Status: In production. In service with many countries including Australia, Canada, the United Kingdom and the United States.

Manufacturer: British Aerospace Defence Limited, Royal Ordnance Division, Euxton Lane, Chorley, Lancashire PR7 6AD, UK.

Telephone: (0257) 265511 Telex: 67441 Fax: (0257) 242199

GKN Defence Warrior advancing through its smoke screen

UNITED STATES OF AMERICA

Brunswick Multi-Salvo Smoke Grenade Launcher

Development/Description

Late in 1990, following a competition, Brunswick Defense was awarded a US Army contract worth \$3 million for the development and initial production of the Multi-Salvo Smoke Grenade Launcher (MSGL).

This will be installed on the M1/M1A1/M1A2 series of MBTs, the M2/M3 Bradley IFV/CFV and future vehicles.

Under the terms of the three year contract, a total of 1300 dischargers are to be delivered by 1994, although the long term potential is for as many as 80 000 units as it is expected to become the standard grenade launcher of the US forces replacing the current six round system originally developed in the United Kingdom and subsequently made in the United States.

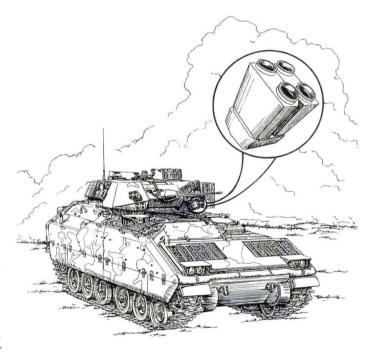
The XM6 Multi-Salvo Smoke Grenade Launcher will consist of the four round launcher, adaptor, plates and alignment tools with each vehicle having at least four systems to cover the frontal arc.

Status: In production for the US Army.

Manufacturer: Brunswick Defense, One Brunswick Plaza, Skokie, Illinois 60077, USA.

Telephone: (904) 736 1700

Artist's impression of XM6 Multi-Salvo Smoke Grenade Launcher (MSGL) mounted on an M2/M3 Bradley IFV/CFV



^{*} at a wind velocity of 24 km/h

Tracor Aerospace Advanced Smoke Launcher System

Development/Description

The Advanced Smoke Launcher System has been developed as a private venture by Tracor Aerospace and was first announced in 1985.

The system can be configured for the British L8 (visual) and US M76 (infra-red) obscurants and can be employed to support both offensive and defensive movement through the suppression of enemy acquisition and fire-control systems.

It has a multi-shot capability to reduce reloading and to facilitate screening on the move and can dispense visual and/or obscurant grenades for multi-spectral screening.

The operator has a panel to enable him to select left or right launchers to screen the flanks or to give the maximum possible screening across the front of the vehicle. The number of rounds per salvo can be varied to suit the tactical situation.

The flat panel operator's display can, if required, be integrated with the existing vehicle crew display. Programs are available to select multiple payloads and to preselect firing sequences and there is growth potential to interface with VIDS-DMS and/or sensors.

For trials purposes the Tracor Aerospace Smoke Launcher System has already been installed on the prototype of the private venture FMC Corporation Close Combat Vehicle – Light. In this application a total of 16 tubes in groups of four-tube modules are arrayed using a custom base on either side of the turret so that they cover the complete frontal arc of the vehicle.

The FMC CCV - L has recently been adopted by the US Army to meet its Armored Gun System (AGS) requirement, but production vehicles will not have this system fitted.

Status: Development complete. Ready for production.



Prototype of FMC Corporation Close Combat Vehicle – Light, fitted with Tracor Aerospace Advanced Smoke Launcher System

Manufacturer: Tracor Aerospace, Expendables Division, PO Box 196, San Ramon, California 94583-0196, USA.

Telephone: (510) 837 7201 Fax: (510) 820 5772

M76 Infra-red Smoke Grenade

Development

In the 1970s the US Army fitted its armoured vehicles with smoke grenade launchers which fire the standard British Royal Ordnance L8 red phosphorous smoke grenade. The launchers are designated the M239, M243, M250, M257 and M259 and vehicle types include the M1/M1A1, M2/M3, M901 Improved TOW Vehicle, M981 FISTV, members of the M113A1/M113A2 family of full tracked APCs, Light Armored Vehicle and M88A1 ARV.

Although the L8 (qv) provides a smoke screen that will last for about three minutes which will allow the vehicle to redeploy to another position, it has minimal effect on threat weapons operating in the mid- or far infra-red regions of the electromagnetic spectrum.

The development programme for the M76 (at that time designated the XM76) started in 1979 under the Army Office of the Project Manager for Smoke/Obscurants (PM Smoke) at Aberdeen Proving Grounds.

The prime contractor during the development of the M76 was the AAI Corporation with the US Army Chemical Research and Development Center providing the PM Smoke with engineering support.

Following extensive trials this was type classified as the M76, the first munition designed to defeat, for 45 seconds, threat weapon sensors operating in the visual through to far infra-red regions of the electromagnetic spectrum.

In November 1985 Tracor Aerospace was awarded the initial contract for the M76 infra-red smoke grenade, worth \$1.5 million, with first deliveries being made in 1986.

In May 1988 Tracor announced that it had been awarded a \$4.4 million add-on production contract for M76 infra-red smoke grenades. This contract was awarded by the US Army Armament, Munitions and Chemical Command and was the fourth-year increment of a \$22.6 million production contract it had been carrying out since 1985. In October 1988 Martin Electronics Inc of Perry, Florida was awarded a \$6.089 million firm fixed price contract for 181 840 M76 smoke IR screening grenades to be delivered by November 1990.

In September 1991 Martin Electronics Inc was awarded a further contract valued at \$8 814 016 for the supply of 214 946 M76 smoke grenades with deliveries to be completed by August 1993.

Description

The M76 grenade consists of a plastic body, which houses the grenade launch system, a safe and arm mechanism that allows detonation only when the grenade has been launched, and a smoke composition.

The grenade launch system is made up of electrical contacts and an electric match mounted on a propellant. When a grenade is fired, propellant pressure is vented behind the grenade through a thin rupture disc in the propellant retainer.

The safe and arm mechanism is designed to interrupt the delay detonator, transfer lead, booster and burster explosive train by positioning the transfer lead safety out of line until the grenade functions. This transfer lead is mounted in a spring-loaded aluminium slider.

The pyrotechnic time delay is contained in an aluminium housing while the booster and the composition A5 burster are housed in plastic. The slider assembly is moved further out of line when the grenade is inserted in the launcher tubes, which simultaneously unlocks the setback pin.

When the grenade is launched, the propellant initiates the time delay and launch acceleration causes the setback pin to move rearward, disengaging the slider. At muzzle exit, the slider moves the transfer lead into alignment with the explosive train. The delay initiates the detonator-transfer lead-booster-burster train at the prescribed range, emitting the smoke composition into an aerosol cloud.

SPECIFICATIONS

 LENGTH
 238 mm

 DIAMETER
 66 mm

 WEIGHT
 1.84 kg

 RANGE
 30 m

Status: In production. In service with the US Army. Interoperable with the British L8 (66 mm) smoke grenade system.

Manufacturer: Tracor Aerospace, Expendables Division, PO Box 196, San Ramon, California 94583-0196, USA. Telephone: (510) 837 7201 Fax: (510) 820 5772

Recent production of the M76 has been undertaken by Martin Electronics Inc of Perry, Florida (see text).



General Dynamics, Land Systems Division, M1 MBT after it has fired a salvo of M76 infra-red smoke grenades over the frontal arc

Tracor Aerospace Advanced Countermeasure Dispenser System

Development/Description

In November 1985 Tracor Aerospace was awarded a contract by the US Army Tank Automotive Command to design and fabricate a Programmable Countermeasure Dispenser System (PCDS) for Army vehicles. The PCDS was designed for a US M1 MBT and provides the following features:

(1) dispenses multiple round types:

visual: L8 type infra-red (IR): M76 flare

- (2) 360° azimuthal coverage (independent of turret position)
- (3) multi-salvo capability
- (4) programmable dispenser control
- (5) variable quantity of rounds per salvo
- (6) inventory status in each pointing direction.

The system can dispense multiple salvos of the British L8 (visual) and US M76 (IR) obscurants along any azimuth, regardless of turret or vehicle position. Based upon the tactical situation, the number of rounds per salvo can be varied and preselected firing sequences employed to support both offensive and defensive movement through the suppression of enemy acquisition and fire-control systems. This system was successfully tested by the US Army at Dugway Proving Grounds in October 1986.

In 1987, Tracor Aerospace upgraded the PCDS by integrating a laser warning receiver and overhead or canopy dispensers. The upgraded system, known as the Advanced Countermeasure Dispenser System (ACDS) contains the following additional performance features:

- identification of laser threat by type (range finder, designator or beam rider)
- (2) azimuthal location of incoming threat
- (3) audio alarm over vehicle intercom
- (4) multiple control modes (automatic, semi-automatic or manual)

(5) four salvos of overhead coverage

(6) compatible with VIDS-DMS via MIL-STD-1553B interface.

The ACDS comprises six dispensers, a control unit, cables and dispenser mounting brackets. The system is designed to provide improved survivability to ground combat vehicles through greater system capability. It is capable of providing a hemispherical umbrella of visual (L8) and IR smoke (M76), obscuring the vehicle from any azimuth and aspect.

There are 24 azimuthal launch directions, 16 provided by the two aft dispensers and eight provided by the two forward dispensers. The aft dispensers provide one salvo of each grenade type along each pointing direction and the forward dispensers provide two salvos of each grenade type along each pointing direction. The multi-salvo frontal coverage is in response to the dominant threat direction from the turret front and eliminates the need to reload after each salvo.

Two canopy dispensers provide overhead coverage along four pointing directions. Two dispensers are angled forward and outboard while two are angled to the rear and outboard. Each pointing direction has four salvo capability for protection against airborne threat without the need to reload.

The ACDS controller is capable of automatic, semi-automatic and manual operation. In the automatic mode the controller determines the threat type and location then automatically dispenses a salvo of eight rounds centred along the threat azimuth. In the semi-automatic mode, the controller continues to determine threat type and location, but it is up to the vehicle commander to dispense the rounds by pushing the fire button. Manual operation requires the commander to select round type, quantity and direction prior to pushing fire button.

In September 1987 the ACDS system was mounted on a Chieftain MBT and successfully tested at the Armoured Trials and Development Unit in Bovington, England.

Status: Development complete. Ready for production.

Manufacturer: Tracor Aerospace, Expendables Division, PO Box 196,

San Ramon, California 94583-0196, USA.

Telephone: (510) 837 7201 Fax: (510) 820 5772

Rockwell Small, Low-Cost Interceptor Device (SLID)

Development/Description

In September 1992, the Tactical Systems Division of Rockwell International announced that it had been awarded a \$194 713 six month study contract for a family of SLID (Small, Low-Cost Interceptor Device) concepts for short range point defence by the US Army's Armament Research, Development and Engineering Centre (ARDEC).

Under the six month fixed price contract, Rockwell will refine SLID concepts for specific missions and prepare a programme plan including test and evaluation procedures for the hardware development phase.

Anticipated performance, size, weight, costs and technical risk and follow-on demonstration programme will also be defined.

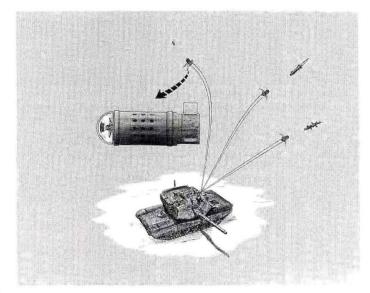
The Rockwell SLID concept envisions small, less than 4.5 kg, low-cost short-range hit-to-kill vehicles similar to the Strategic Defence Initiative (SDI) Brilliant Pebbles programme. These would be capable of high agility lateral manoeuvres and have no propulsion except from a mortar type launcher mounted on the roof of the vehicle.

The SLID would give a self-defence capability to armoured vehicles, including tanks, and otherpoint targets being attacked by missiles, projectiles or low-flying aircraft. A Circular Error of Probability (CEP) of 50 mm is expected as a requirement to hit incoming missiles reliably.

Status: Study phase.

Contractor: Rockwell International, Tactical Systems Division, 1800 Satellite

Boulevard, Dulluth, Georgia 30136, USA. Telephone: (404) 476 6300 Telex: 7664 917



Artist's impression of an M1 series MBT launching several SLIDS to combat incoming missiles

Laser Detectors

(This section now contains radar detectors and other elements of integrated vehicle protection systems)

FRANCE

Thomson-CSF MIRIADE Radar Warning Receiver

Development/Description

The MIRIADE radar warning receiver has been developed by the Radars and Countermeasures Division of Thomson-CSF Aerospace Group to provide maximum survivability for the crews of armoured vehicles and helicopters faced with threats from millimetre wave systems used in homing heads, target designation radars and fire-control radars.

The sensor, which weighs less than 8 kg, is mounted on the roof of an MBT and immediately informs users of the presence and position of threats so that the right countermeasures can be quickly triggered.

MIRIADE uses technology pioneered in other programmes and has adjustable sensitivity to match the threat range.

Status: Development.

Manufacturer: Thomson-CSF Aerospace Group, Radars and Countermeasures Division, 178 boulevard Gabriel Peri, F-92242 Malakoff Cedex. France.

Telephone: (33) 1 46 55 44 22 Telex: THOM 616 780 F



Artist's impression of the Thomson-CSF MIRIADE millimetric radar warning receiver fitted to a Giat Industries Leclerc MBT

CSEE Defense EIREL Infra-Red Countermeasures System

Development/Description

The EIREL infra-red countermeasures system was developed as a private venture by CSEE Defense but was adopted by the French Army for installation on its Giat Industries AMX-10RC (6×6) armoured vehicles which subsequently took part in Operation Desert Storm, the liberation of Kuwait, early in 1991.

According to CSEE Defense, the main characteristics of the EIREL infrared jammer are that it provides permanent protection against a wide range of threats, it can be quickly installed on most armoured fighting vehicles and is very reliable.

The scanner type device is normally mounted on the roof or side of the tank to cover the vulnerable frontal arc with the control box being mounted inside the turret.

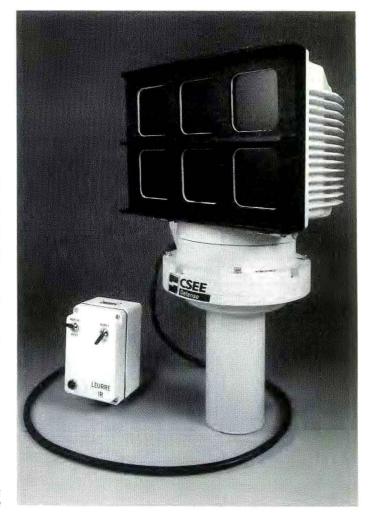
The EIREL infra-red jammer has two operational modes for different threats and can also be used in conjunction with an alarm detector. It is normally powered from an onboard 28 V DC power supply although different versions exist according to the power supply available on the vehicle. It is claimed to be very reliable with an integrated back-up mode providing permanent protection.

Status: Production. In service with the French Army on AMX-10RC (6×6) armoured vehicles.

Manufacturer: CSEE Defense, ZA de Courtaboeuf, 6 avenue des Tropiques, BP 80, F-91943 Les Ulis Cedex A, France.

Telephone: (1) 69 86 85 00 Telex: 600 015 F

Fax: (1) 69 07 03 70



CSEE Defense EIREL infra-red countermeasure system with control box

GERMANY

Deutsche Aerospace AG Common Opto-Electronic Laser Detection System (COLDS)

Development/Description

The Common Opto-electronic Laser Detection System (COLDS) has been developed since the early 1980s by the Defence Systems Group of Deutsche Aerospace AG to provide a reliable, lightweight, EMI/EMC resistant multispectral target acquisition system for all airborne and surface platforms.

COLDS is able to detect all actual and future laser threats so enabling selected countermeasures by the precise determination of the threatening laser type, direction and coding.

It is adaptable to a variety of platforms and has been trialled in Germany, the United Kingdom and the United States. In the case of the United Kingdom, it was installed on a Chieftain MBT and used in conjunction with the Tracor Aerospace Advanced Countermeasure Dispenser System (qv previous section).

Key specifications of COLDS can be summarised as follows: (1) very high EMI/EMP resistance, (2) sensor heads tailored to the platform, (3) high angular resolution in azimuth and elevation, (4) high-speed processing, (5) multiple wavelength coverage, (6) very high false alarm immunity, (7) pulse width discrimination, (8) PRF measurement and pulse code interval, (9) adaptive threshold, (10) reflection suppression, (11) high sensitive single pulse detection capability, (12) high power channels, (13) multiple threats, (14) extended threat analysis and (15) optical BITE.

System performance data

WAVELENGTH RANGE

 $\begin{array}{l} 0.4 \leq \geq 2.0 \mu m \\ 2.0 \leq \geq 5.0 \mu m \text{ optional} \end{array}$

ANGULAR COVER

 $5.0 \le \ge 12.0 \mu m$ optional 360° in azimuth $\pm 45^{\circ}$ in elevation

ANGULAR COVER

ANGULAR RESOLUTION

DETECTION CAPABILITY DYNAMIC RANGE

±3°in azimuth elevation optional all known laser threats > 100 dB (signal voltage)

Variant

In 1991 a new version of COLDS was evaluated by the United States Army Tank Automotive Command. Tracor Aerospace, Deutsche Aerospace AG, United States licensee, has been awarded a contract by LTV to supply an upgraded version of COLDS which is to be tested by Tank Automotive Command as part of the Vehicle Integrated Defense System.

The improved version of COLDS will have an expanded frequency coverage to allow it to detect carbon dioxide laser rangefinders (operating at 10.6 $\mu m)$ such as those fitted to the latest MBTs like the Challenger 2 and M1A1. Earlier versions had an upper limit of 1.9 μm which is suitable for ruby and Nd:YAG laser rangefinders and designators.

This will be tested with a smoke discharger system developed by Tracor Aerospace. Tank Automotive Command and Communications and Electronics Command have awarded AIL a separate contract to supply a complimentary millimetre wave Radar Warning Receiver (RWR) for tank applications (qv).

According to Deutsche Aerospace AG, the COLDS processor has the capacity to handle both laser and radar warning receiver inputs should a fully integrated system be required and the company is already working on such a system for the German Army in association with Krauss-Maffei (prime contractor) and Wegmann and Buck.

Status: Prototype systems.

Manufacturer: Deutsche Aerospace AG, Defence Systems Group, PO Box 80 11 49, D-8000 Munich 80, Federal Republic of Germany. Telephone (089) 6000 - 8507 Telex: 5287 - 460 mbb d

Fax: (089) 6000 - 8262

ISRAEL

AMCORAM LWS-2 Laser Warning System

Development/Description

The new Merkava Mk 3 MBT, first shown in 1989, is fitted with the LWS-2 advanced threat warning system which has been developed by AMCORAM, a member of the AMCOR Group.

The system provides an alert whenever optical radiation is aimed at the vehicle from any direction and warns against enemy presence and attack intentions all in real time.

The indication includes the type of radiation including infra-red searchlight, laser rangefinder and a laser designator, with additional options being available according to the customers specific operational requirements. The RS-232 output is to the main tank computer.

The complete LWS-2 laser warning system comprises three radiation sensors which are positioned around the vehicle, typically on the turret, to give a full 360° coverage, a data processing unit, a command, control, display unit which also includes operation and test switches indicator and interconnecting wiring harnesses.

The sensing element is tailored to the type of vehicle which it is intended for while the display unit provides the commander with the following information:

- (1) Threat indentification
- (2) Visual directional display of threat source, clock dial style or digital display
- (3) Audio alert to the commander and/or crew

The display unit includes an indication of the type of radiation detected, multiple radiation sources detection, source direction and system failure alert.

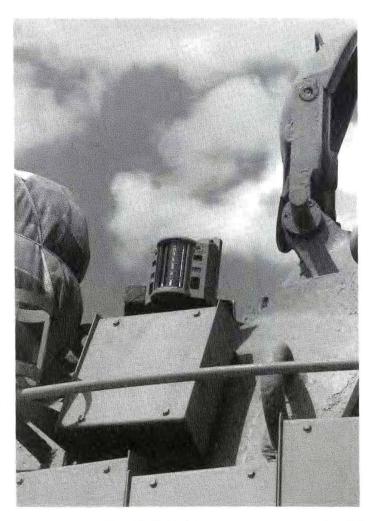
The display unit also includes the following operation and command controls: main power switch, audio mute switch, day/night illumination intensity switch, test push-button and additional/prior threat.

As far as it is known, the Merkava Mk 3 is the first MBT to be fitted with a threat warning system as a standard production system.

Status: In production. In service with the IDF on the Merkava Mk 3 MBT.

Manufacturer: AMCORAM, 10 Hapeled St Industrial Zone, IL-Holon 58811, Israel

Telephone: (972) 03 - 805533 Fax: (972) 03 - 805536



Sensing element of the AMCORAM LWS-2 laser warning system installed on an MBT

Moked Third Eye Laser Warning System

Development/Description

The Third Eye laser warning system has been developed by Moked Engineering (1969) to meet the requirements of the Israel Defence Forces and it has been installed on their tanks for several years.

It has been designed for the instantaneous detection of laser rangefinders, designators and infra-red searchlights. It indicates the direction and type of threat on a display screen provided for the tank commander. An audio warning is also provided through the vehicle intercom net.

The sensor is mounted on a 45 cm high mast that is installed on the tank turret and comprises four sensor groups each of which consists of infra-red and laser sensors. It has been designed to provide a credible warning at all combat ranges and be insensitive to combat by-products such as explosions, flash or smoke

It can differentiate between the various types of laser and in addition has an arrow composed of LED lights that blink to indicate the direction of the detected threat. This signal will continue to blink even after the laser is turned off so enabling the defender to operate countermeasures against target designators, rangefinders and infra-red sources.

According to the manufacturer, the Third Eye system has been in operational use with the IDF and has proven its performance and reliability under field conditions.

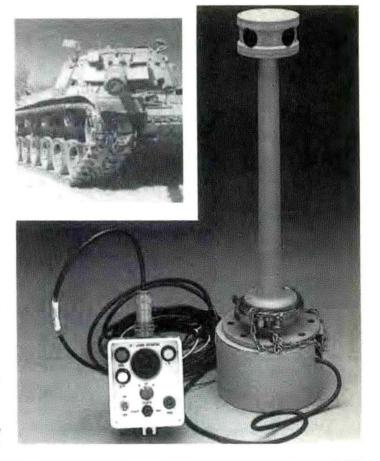
In addition, a complementary sophisticated training system, especially designed to train Third Eye users without exposing them to damaging laser beams, is also available. The training system's operation is based on data transfer through the communications system of the AFV on which it is mounted.

Status: Production. In service with the Israeli Army.

Manufacturer: Moked Engineering (1969) Limited, 5 Shatner Center, Givat Shaul, PO Box 3454, IL-91034 Jerusalem, Israel

Telephone: (972) 2-527141 Fax: (972) 2-511133

Moked Third Eye laser warning system with display box lower left and inset top left M60 series MBT which is fitted with this system



NORWAY

SIMRAD RL 1 Laser Warning Receiver

Development/Description

The RL 1 laser warning receiver has been developed as a private venture by SIMRAD to provide armoured vehicles, helicopters and surface craft with the capability to detect radiation from pulsed laser rangefinders and target markers. The instrument can detect pulsed radiation within the 0.66 to 1.1 µm near infra-red band, covering the most common types of pulsed lasers (Ruby, GaAs, Neodymium) currently being used in rangefinders and target markers. The instrument does not detect continuous radiation.

The detector unit mounted on top of the vehicle has a 360° field-of-view and can in addition detect radiation coming from above. An indicator unit is mounted inside the vehicle and this indicates the approximate direction to the radiating source by means of Light Emitting Diodes (LEDs) mounted in

Eight 45° sectors are indicated; a ninth LED mounted in the centre indicates radiation received from above. Because of the overlapping fieldsof-view, a total of 17 sectors can be indicated.

The receiver will give an acoustic alarm consisting of a pulsed audio signal when a laser pulse is detected. The duration of the alarm is two seconds for a single laser pulse. When more than one pulse is being detected the alarm stays on as long as laser pulses are being received.

SPECIFICATIONS

Indicator Unit

OPERATING TEMPERATURE RANGE -40 to +70°C **Detector Unit** NUMBER OF DETECTORS horizontal 4 vertical DETECTOR FIELD-OF-135° VIEW TYPE OF DETECTOR PIN photodiode DETECTOR ACTIVE AREA 1 mm OPTICAL BANDWIDTH 0.66 to 1.1 µm FALSE ALARM RATE <10⁻³ per hour

RESOLUTION horizontal 45 vertical 45 NUMBER OF SECTORS 8 horizontal vertical DISPLAY BRIGHTNESS >100x RANGE DURATION, ACOUSTIC ALARM 25 **DURATION DISPLAY** OPERATING VOLTAGE 20-32 V (24 V nominal)

Status: Production as required. By early 1993 about 50 production systems had been completed. The SIMRAD RL 2 laser warning receiver (Jane's Armoured Fighting Vehicle Systems 1989-90 page 190) is no longer produced

Manufacturer: SIMRAD Optronics A/S, PO Box 6614 Etterstad, N-0602 Oslo 6. Norway

Telephone: 47 2 67 04 90 Telex: 76136 SIM N Fax: 47 2 19 29 91



SIMRAD RL 1 laser detector system with display unit (left) and detector unit (right)

ROMANIA

Warning System on Laser Illumination (WSLI)

Development/Description

The Warning System on Laser Illumination (WSLI) has been designed for installation on tracked and wheeled armoured vehicles to enable vehicle crews to take action to avoid being hit.

The four main components of the WSLI are the power supply and signalling unit mounted inside the vehicle, detector units mounted outside the vehicle, normally on the turret and the interconnecting cables. In addition there is a portable test device

The system is not influenced by solar radiation, high-powered searchlights, electrical dischargers, artillery blasts, fires or radio equipment operating nearby.

SPECIFICATIONS

DETECTOR SIZE SIGNALLING UNIT DETECTED RADIATION **SPECTRUM**

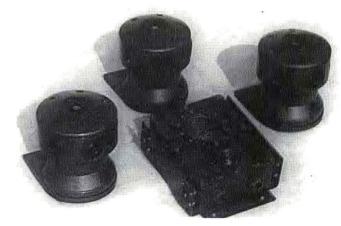
SIGNALLING DURATION SIGNALLING MODE 130 diameter × 120 mm high 225 × 200 mm

12 directions horizontal plane, 3 directions in vertical plane

optical for direction and warning duration, acoustic for every detected pulse

Status: Believed to be in production and in service with the Romanian

Manufacturer: Romanian state factories.



Warning System on Laser Illumination (WSLI) with signalling unit in centre and three circular detection units

SLOVENIA

Iskra Laser Irradiation Detector and Warner

Development/Description

The Iskra Laser IRradiation Detector and warner (LIRD) has been designed for use in both vehicle and shipborne applications and entered production in 1986. The earlier Iskra Laser Irradiation Detector (Jane's Armoured Fighting Vehicle Systems 1989-90 page 194) is no longer manufactured.

The purpose of the LIRD is to reduce vehicle vulnerability to the numerous laser associated weapon threats by providing the crew with a warning that their vehicle is being irradiated by a pulsed laser from a laser rangefinder or a laser illuminator/designator. The crew can then take appropriate self-protective action (manoeuvre and/or deployment of a smoke screen) or counterfire

The LIRD has been designed in modular form to accommodate the wide range of different requirements

There are versions of LIRD to provide discrimination between laser rangefinder and laser illuminator, between direct and indirect irradiation, between low and high power irradiation and with different (15 to 45°) direction determination.

The system can also respond to illumination from infra-red searchlights and can integrate radar warning receivers as well as be interfaced to an automatic smoke discharging system.

The basic system consists of two separate units: detector head unit and indicator unit with appropriate cables and mounting parts.

The detector head unit is mounted on the superstructure of a vehicle, preferably so that the input apertures are free of any obstruction. The detector head unit consists of two or three detection system modules: direct detection module, indirect detection module and (optionally) infra-red searchlight detection module.

The indicator unit is installed in an adequate clearly visible location in the tank turret and consists of a display, signal processing circuitry, generators of visual and audio signals and power supply circuitry.

The direct detection module senses the laser beams which directly hit the vehicle and the detector head unit. Depending on the LIRD type it can consist of 4 + 1, 8 or 12 receivers of laser beams. In all possible configurations their combined fields-of-view cover a horizontal area of 360°. The fieldof-view in elevation is minimum 80° (-20 to +60°) and maximum 150° (-60 to +90°). The direct detection module covers a spectral range from 0.66 to 1.1 µm and is thus able to detect all kinds of ruby, GaAs and neodymium lasers (extensions to the infra-red field are already under development).

The unwanted section of light spectrum is attenuated by a special optical filter, which in combination with EMI protection provides a very low false alarm rate.

As an option there is a direct detection module for sensing the infra-red searchlight beams.

The indirect detection module senses the target-off laser beams which indirectly irradiate the instrument, and consists of a special optical system and a laser receiver. Spectral response is 1.064 µm (Nd lasers). The unwanted section of the light spectrum is cut off by an optical narrowband filter

Signals from the detector head unit are routed via a signal cable to the processing circuitry in the indicator unit. The processing circuitry starts the generators of audible alarm and supplies the display with signals for visual indicators. The duration of audible alarm is two seconds minimum. While being irradiated or illuminated (laser target designators) the duration of visual indicators is approximately eight seconds.

The display on the indicator unit has, depending on LIRD type, nine to 24 LEDs which indicate the direction of incoming irradiation and two to four LEDs for laser threat characterisation.

All controls are situated on the front panel of the indicator unit and the detector is activated with the on/off switch.

LIRD is supplied from the power supply network of normal voltage 24 V DC from an external battery and normally operates at voltages between 15 and 30 V DC.



Close-up of T-55 MBT showing detector head (foreground) with indicator unit below left periscope at commander's position

Status: In production.

Manufacturer: Iskra Elektrooptika Ljubljana DD, Stegne 7, PO Box 59, Si-61210 Ljubljana-Sentvid, Slovenia.

Telephone: (061) 571 303 Telex: 39518 ISKCEO

Fax: (061) 575 985

SPECIFICATIONS MODEL	LIRD	LIRD-1A	LIRD-2	LID-2
Detector head unit				
DIRECT DETECTION MODULE	all are 0.66-1.1µm			
NUMBER OF RECEIVERS	8	10	12	5
RECEIVER FIELD-OF-VIEW AZIMUTH	45/60/160°	45/60/160°	45°	150°
ELEVATION	80°	80°	80°	135°
	(-20/+60°)	(-20/+60°)	(-20/+60°)	(±67.5°)
FIELD-OF-VIEW IN AZIMUTH	360°	360°	360°	360°
Indirect detection module				
SPECTRAL RANGE	all are $1.060 \pm 0.50 \mu m$			
NUMBER OF RECEIVERS	1	1	1	nil
FIELD-OF-VIEW IN AZIMUTH	360°	360°	360°	_
FIELD-OF-VIEW IN ELEVATION	6°	6°	6°	_
IR searchlight detection module	sowere three			
SPECTRAL RANGE	0.66-1.1 μm			
NUMBER OF RECEIVERS	8			
RECEIVER FIELD-OF-VIEW				
in azimuth	45/60/160°			
in elevation	80° (-20 to +60°)			
TOTAL FIELD-OF-VIEW				
in azimuth	360°			
in elevation	80°			
DIMENSIONS (diameter/height)	150/200 mm	150/200 mm	170/255 mm	74/74/90 mm
WEIGHT	3.2 kg	3.2 kg	5.8 kg	1.2 kg
Indicator unit (KI 1 and KI 2)				
ANGULAR RESOLUTION IN AZIMUTH	15° forward looking receivers 15/30° sideways looking receivers 105° backward looking receivers	15°	45°	
ANGULAR RESOLUTION IN ELEVATION	nil	nil	nil	45°
NUMBER OF RESOLUTION SECTORS IN AZIMUTH	16	16	24	8
NUMBER OF RESOLUTION SECTORS IN ELEVATION	1	1	1	5
Threat characterisation				
LASER RANGEFINDER	LR	LR	LR	LR
LASER ILLUMINATOR	LI	LI	LI	LI
INDIRECT RADIATION	IND	IND	IND	nil
HIGH POWER IRRADIATION	nil	HPI	HPI	nil
IR SEARCHLIGHT IRRADIATION	IR	nil	nil	nil
Dimensions				
KI 1 INDICATOR	62 × 120 × 190 mm			
KI 2 INDICATOR	75 × 120 × 190 mm			
WEIGHT KI 1	1.6 kg	1.6 kg	1.6 kg	1.6 kg
WEIGHT KI 2	2 kg	2 kg	2 kg	2 kg

UNITED KINGDOM

Avimo Laser Warning Device LWD 21

Development

The laser warning device LWD 21 has been developed as a private venture by Avimo as a low-cost detection system which requires little maintenance and has the adaptability to be a common fitting on a wide range of vehicles. It was first announced in 1988.

The system provides the vehicle commander with an immediate simultaneous audible and visual warning of the presence of hostile laser radiation. It detects most laser and infra-red energies used in modern warfare and indicates the direction and type of attack.

Continuing research and development of LWD 21 is aimed at the successful detection of a wider range of laser types, specifically Erbium in Glass and Raman Shifted Neodymium-YAG at the 1.53 μm wavelength.

Description

The laser warning device LWD 21 comprises two compact units, the detector head and the display/control unit.

The laser detector head is a sturdy aluminium housing that contains all of the receiver opto-electronics, mounted on the top of a flexible mast which is attached to the turret of the vehicle. The mast allows the detector head to be deflected when in contact with any obstructions when the vehicle is moving across country. It automatically returns to the operational, for example the vertical position, when the obstacle has passed.

A single silicon photodiode on the top of the detector head provides the means of vertical detection while an array of another 12 photodiodes around its circumference detects in azimuth. For total protection, all of these diodes have overlapping fields-of-view.

Any radiation detected is processed in the head and then transmitted to the control system in the display unit, via an interconnecting cable which passes through the centre of the mast so protecting it from damage by external sources.

The compact display unit is mounted in a convenient position at the commander's station and houses the processing circuitry and all of the controls and indicators required for operational use.

The processing circuitry is controlled using a CMOS microprocessor which also provides a BITE function to monitor the system. Automatic internal testing occurs when the system is switched on and is carried out automatically while the system is operating. An external socket is provided for standard RS-422 data output which can be utilised as a communications link to enable automatic deployment of the vehicle's defensive system.

Separate remote display units for the gunner and/or driver can also be provided together with sensors/encoders to compute the appropriate directional data of turret/hull relationships.

When the LWD 21 system is operating it gives an audible and visual warning of a potential attack within 0.2 seconds of detection; it always displays the latest information. The front panel visually provides the following information regarding a threat:

- (a) azimuth angle of attack is displayed by a ring of 24 LEDs for rapid angular reference plus a direct reading central hexadecimal display that can be preset to read mils or degrees
- (b) overhead attack is indicated by illumination of a single LED
- (c) operational type of attack with three bar LEDs indicating either single pulse (rangefinder), multiple pulse (designator) or infra-red sources.

The audible warning is given by an integral solid state buzzer which may be inhibited or presented through headphones via the socket provided.

There are six operator's controls: power switch, power indicator, audio switch, infra-red switch, reset button and DIM button.

SPECIFICATIONS

FIELD-OF-VIEW AZIMUTH (horizontal) FIELD-OF-VIEW AZIMUTH (vertical) OVERHEAD AZIMUTH RESOLUTION SPECTRAL RESPONSE TO

OPERATIONAL TYPES

RESPONSE TIME

CONSUMPTION

POWER

RANGE

360°
-12 to +47°
140°
± 7.5°
0.532 um (fre

0.532 μm (frequency doubled Nd:YAG)

0.694 μm (Ruby) 0.85-0.95 μm (GaAs)

1.06-1.064 µm (Neodymium Glass and Nd:YAG) infra-red (night only) single pulse rangefinders multiple pulses (designators) better than 0.2 s

20 to 32 V DC vehicle 10 W (nominal)

-40 to +55°C

140 mm 350 mm

120 × 120 × 100 mm

Status: Production as required.

OPERATING TEMPERATURE

DETECTOR HEAD DIAMETER

DETECTOR HEAD HEIGHT

DISPLAY UNIT SIZE

Manufacturer: Avimo Limited, Lisieux Way, Taunton TA1 2JZ, UK. Telephone: (0823) 331071 Telex: 46126 Fax: (0823) 274413



Avimo Laser Warning Device LWD 21 with display/control unit (left) and detector head (right)

Helio Mirror Company LWD 21 Laser Warning System

Development/Description

The Helio Mirror Company has teamed with Avimo, producers of lasers and optical devices, to produce a versatile system giving instantaneous warning detection from laser rangefinders and designators coupled with automatic smoke screen protection. The system can be fitted readily to virtually any armoured fighting vehicle.

The system consists of a detector head mounted on the vehicle surrounded by a 360° ring of grenade dischargers. A commander's display panel is mounted within the vehicle as is the grenade discharge control box. The detector head and the commander's display/control box are the same as those used in the laser warning device LWD 21 described in the previous entry while the grenade launchers are covered in the *Smoke Dischargers*, *Grenades and Decoys* section under the United Kingdom.

In principle the detector head with its 12 sensors plus one overhead sensor, covers a 360° semi-sphere detecting the presence of laser radiation in the vicinity of the vehicle. It is capable of identifying the type of attack and its direction. When the system is switched to automatic this detection will trigger a salvo of eight grenades out of a total of 16 giving a complete 180° windowless smoke screen spaced either side of the centre of attack.

With the air bursting grenades this screen is obtained within two seconds of grenade release. At the same time visual and audible warning is displayed and employed on the commander's display unit indicating the direction of the attack.

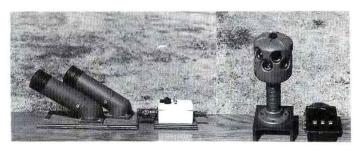
If the Helio grenade control box is set to manual, then only the visual and audible warning is utilised. Grenades can, in this situation, be manually discharged at the commander's discretion.

The system can be supplied for either the 66 mm or 76 mm grenade.

Status: Production. In service with an undisclosed country.

Manufacturer: Helio Mirror Company Ltd, Crabtree Manorway South, Belvedere, Kent DA17 6AY, UK.

Telephone: (081) 311 4140 Telex: 8951666 Fax: (081) 311 1004



Helio Mirror Company LWD 21 laser warning system, from left to right, 66 mm grenade dischargers, discharger control box, mast-mounted laser warning detector and commander's display/control box

GEC-Marconi Dynamics Systems Tank Anti-Missile System (TAMS)

Development

In mid-1988 GEC-Marconi Dynamics announced that it was developing, as a private venture, the Tank Anti-Missile System (TAMS) to protect tanks, APCs and command vehicles against incoming anti-tank guided weapons of the wire-guided, laser-guided, heat seeking, side or top attack or even terminally guided mortar bombs with a speed of around 400 m/s. The system can also be used for the protection of point targets such as airfield Hardened Aircraft Shelters (HAS) and operations rooms, which is called the Point Anti-Missile System (PAMS).

GEC-Marconi Dynamics is prime contractor and systems integrator as well as being responsible for the millimetric radar, with Lucas providing the turret and Royal Ordnance the twin 7.62 mm McDonnell Douglas Helicopter Chain Guns.

At present TAMS is still at the development stage and no complete prototype has so far been completed. GEC-Marconi Dynamics estimates that the total cost of TAMS system would be about one tenth of the cost of an MBT.

The design of TAMS is a modular construction so that it can be reconfigured to the customer's requirement using local manufacture for most parts and incorporating national preferences in armament and armour. This allows the millimetric surveillance radar to be offered as a stand-alone alerting radar.

Its design is such that various other Defence Aids (DAS) can be incorporated or substituted and these include missile launch and laser warning devices which may not only alert the system but also provide sufficient information to put the guns on a target themselves.

Description

TAMS essentially consists of a remote-controlled Lucas power-operated turret armed with twin 7.62 mm McDonnell Douglas Helicopter Chain Guns,

with the millimetric wave surveillance radar mounted on top and the millimetric tracking/lock-on (94 GHz) radar mounted between the two machine guns. The lock-on radar is essentially common to the millimetric seeker head, developed by GEC-Marconi Dynamics for the active homing version of Hellfire air-launched missile. All-up weight of a typical TAMS system would be about 100 kg.

The system is protected by armour which has three-fold function: it protects against battlefield debris, against crew damage and the remains of the destroyed target missiles.

TAMS would normally be mounted on the turret roof where it has a full 360° arc of fire with elevation being 90°. The twin 7.62 machine guns have cyclic rate of fire of 1200 rds/min, for example, 600 rounds per gun. A total of 400 rounds (200 per gun) of ready-use ammunition are carried, which is sufficient for 20 engagements of 20 rounds. Effective range is between 600-900 m.

A typical target engagement would consist of target surveillance, turret slew, target tracking and computing of fire control information, opening fire and target engagement. The system is fully automatic and self-contained and only needs to be connected to the vehicle's power supply.

TAMS is a point defence system and strikes only those missiles which will hit the tank unless stopped by distruption of their end game. It is considered to have little capability against aircraft and attack helicopters.

According to GEC-Marconi Dynamics, successive missile attacks soon reduce a large tank force to insignificant numbers. TAMS is claimed to be more than 75 per cent effective in defending against missile and ensures the survivability of a viable force.

Although originally designed for one specific target, GEC-Marconi Dynamics consider it to have potential against homing projectiles, subprojectiles and TGSMs (Terminally Guided Sub-Munitions) and subprojectile carriers.



GEC-Marconi Dynamics TAMS (Tank Anti-Missile System) showing tracking radar mounted between the two machine guns

Status: Development

Manufacturer: GEC-Marconi Dynamics Limited, The Grove, Warren Lane,

Stanmore, Middlesex HA7 4LY, UK.

Telephone: (081) 954 2311 Telex: 22616 Fax: (081) 954 1905

Marconi Series 1220 Laser Warning Receiver

Development/Description

The Laser Warning Receiver (LWR) has been developed as a private venture by Marconi Defence Systems and was unveiled for the first time at the 1986 British Army Equipment Exhibition.

The basic system comprises a 360° detector head and an electronics/ display unit. This may be integrated with other threat warning system displays. The LWR can be used to protect armoured vehicles, fixed-wing aircraft, battlefield helicopters and other high value targets which run the ever-present risk of being illuminated by laser rangefinders and target markers

The LWR combines the use of silicone detectors with wide bandwidth logarithmic amplifiers to give high dynamic range, low noise and a low incidence of false alarms (generated by natural or artificial sources). The design provides a high probability of intercept with the speed that is necessary to implement the appropriate countermeasures.

Spectral resolution, using an optional wavelength discriminating unit, is typically 0.1µm so that the most common military laser types can be identified. Its sensitivity will permit detection of such threats at the limit of their operating ranges, typically several kilometres.

The LWR display unit furnishes a LED indication of threat sector plus an audible warning tone.

The LWR is designed for installation in existing or proposed platforms and can be configured to meet particular needs. Extensive flight trialling on a Sea King helicopter has demonstrated the ability of the receiver to detect a ground-based laser beam source from a variety of heights, angles and distances. Resolution and bearing accuracy were shown to be of a consistently high order.

SPECIFICATIONS

FIELD-OF-VIEW

ANGULAR RESOLUTION

SPECTRAL RANGE

POWER SUPPLY

azimuth 360° elevation 55° (typically -10° to +40° but other elevation biases are available) 45° in azimuth (other resolutions, eg 30° possible) 0.35 to 1.1 µm (extensions to the infra-red in development) 28 V DC (nominal)

DIMENSIONS head unit

display unit

British Army

Wavelength analyser option SPECTRAL RANGE

SPECTRAL RESOLUTION

50 diameter × 25 mm high

127 mm wide 194 mm high 323 mm deep

typically 0.1 µm

 $0.35-1.1 \, \mu m$ (or 1-1.1 $\mu m/8-11 \, \mu m$ as options)

Status: Prototype systems have been evaluated on a Chieftain MBT of the

Manufacturer: Marconi Defence Systems Limited, The Grove, Warren

Lane, Stanmore, Middlesex HA7 4LY, UK. Telephone: (081) 954 2311 Telex: 22616



Marconi Defence Systems Series 1220 laser warning receiver on a Chieftain (Stillbrew) MBT during British Army trials

GEC Ferranti Defence Systems Type 453 Laser Warning Receiver

Development/Description

The Type 453 laser warning receiver has been developed by GEC Ferranti Defence Systems for installation on aircraft, helicopters and armoured fighting vehicles. It reduces their vulnerability from laser assisted weapon threats by providing the crew with a warning that their platform is being illuminated by a pulsed laser as a prelude to a conventional weapon attack. This warning would enable the crew to take the appropriate countermeasures

The system is of modular design both to allow its installation in a wide range of platforms as well as allowing it to be updated at minimum cost and minimum disruption of the platform as new laser wavelengths/types enter

According to GEC Ferranti Defence Systems, the Type 453 is the first laser warning receiver to be offered with passive sensor heads which make them immune to Radio Frequency Interference (RFI).

Key features of the Type 453 can be summarised as passive sensor heads, modular construction, ease of maintenance, minimal projection of sensor heads, common modules, central electronic processing, and can be integrated with existing displays such as a radar warning receiver.

The laser illumination is collected by the directional sensor heads and

then routed to the central electronic processing unit via fibre optic cableforms. The signals are then processed and the crew alerted with an audible alarm and a visual indication of the threat bearing.

SPECIFICATIONS

Sensor heads BANDWITH OPTION AZIMUTH **ELEVATION** SECTOR RESOLUTION

Display ALARM

DURATION, AUDIBLE ALARM

Display VISUAL DISPLAY

ALARM MUTE

IS422 INTERFACE GYRO INTERFACE

Status: Prototype systems.

0.3 to 1.1 µm 0.3 to 1.8 µm

360° 180 45

> audible tone, visual display of direction

2 s minimum or while being illuminated (laser target designators)

10 s minimum or while being illuminated

push-buttons to cancel audible

optional optional

Manufacturer: GEC Ferranti Defence Systems Limited, Display Systems

Division, 1 South Gyle Crescent, Edinburgh EH12 9HQ, Scotland.

Telephone: (031) 316 4545 Telex: 727101 Fax: (031) 314 8237

Passive sensor heads of GEC Ferranti Defence Systems Type 453 LWR (background), display unit (left foreground) and central electronic processing unit (right foreground)

Racal Saviour Laser Warning System

Development/Description

The Saviour laser warning system for armoured vehicles has been developed as a private venture by Racal Defence Systems since the early 1980s and has been demonstrated and trialled on many types of vehicle including the ENGESA Osorio and Vickers Defence Systems Challenger 1 MBTs

According to Racal the installation of Saviour on an armoured vehicle is a cost-effective enhancement of the probability of survival. It provides for the instant warning of threatened attack by laser associated threats, octantal indication of threat direction, and an automatic response initiation. It is easy to install, operate and maintain. It can be installed in new build vehicles as well as being retrofitted to older vehicles.

The system provides the AFV with the equipment necessary to enable the commander and crew to receive an immediate aural warning that the vehicle is being illuminated by a laser rangefinder or designator, an octantal indication of the direction from which the threat is coming and classification of the emission into LRF or designator. As an immediate countermeasure the system includes automatic initiation of the vehicle emergency smoke screen grenades.

The main part of the Racal Saviour system is the roof-mounted laser warning receiver array with four horizontal and one vertical detector and receiver and logic circuits. This is normally mounted on a stub mast on top of the tank turret and provides information to the processor and power supply units mounted in the vehicle, which are connected to the vehicle power supply. Threat information is provided to the commander's control and display unit and the driver's display unit. In addition the system is linked to the vehicle communications system and has an optional extension to the vehicle's smoke discharger system.

A radar warning receiver can be included in the Saviour system if required.

SPECIFICATIONS

COVERAGE **ELEVATION** FREQUENCY RANGE/ OPTICAL BANDWIDTH **DETECTION RANGE**

RESOLUTION DISPLAYED RESPONSE TIME WARNING

360° (or as required) from -22.5 to +90

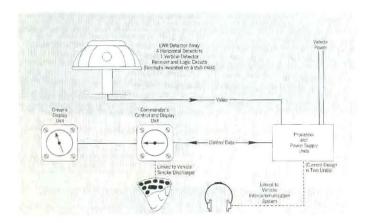
0.66 to 1.1 µm better than emitter ranging capability to within a 45° sector instantaneous audio tone to all crew members (voice as optional extra) Visual display for commander and driver of threat type (laser rangefinder or laser designator) and octantal direction

NUMBER OF SIMULTANEOUS THREATS DISPLAYED

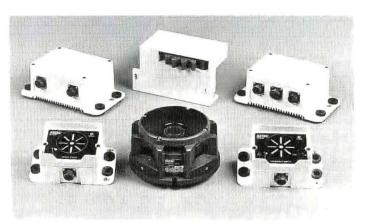
Status: Production as required.

Manufacturer: Racal Radar Defence Systems Limited, Davis Road, Chessington, Surrey KT9 1TB, UK.

Telephone: (081) 397 5281 Telex: 27720



Block diagram of standard Racal Saviour laser warning system



Main components of Racal Saviour laser warning system for AFVs

UNITED STATES OF AMERICA

Vehicle Integrated Defense System

Development/Description

The United States Tank Automotive Command (TACOM) is currently developing a Vehicle Integrated Defense System (VIDS) to enhance the survivability of combat vehicles.

VIDS provides a countermeasures approach to defeating threats as a complement to advanced armour.

The VIDS concept provides an architecture to incorporate threat warning sensors and countermeasure reaction devices. A selectable suite of threat sensors is used to detect, locate and prioritise hostile emitters. A matched set of reaction devices is then used to counter the threat through active and passive means

A data management processor and integrated controls allow the crew to initialise the system to select either interactive or automatic countermeasure responses. The assessed threat situation is displayed to the crew along with warning tones when a threat is detected.

Advanced countermeasures such as multi-salvo smoke, integrated automatic weapon aiming and active protection are expected to provide effective countermeasures to weapons in the year 2000

VIDS can be retrofitted into existing combat vehicles as a field installed kit. Field tests are planned at several US Army installations.

Developing Agency: United States Army Tank-Automotive Command, Warren, Michigan 48397-5000, USA.

Telephone: (313) 574 5788

AIL Radar Warning Receiver

Development/Description

In mid-1989, AIL Systems Incorporated was awarded a contract to design. develop and deliver a Radar Warning Receiver (RWR) system to be installed on MBTs.

Under the terms of the contract, AIL Systems Incorporated will develop a tank RWR subsystem prototype which provides enhanced threat signal detection capability so enabling the MBT to take timely countermeasures thus increasing its survivability against potential and emerging RF threats.

The \$1 million contract is administered jointly by the United States Army Communications and Electronics Command (CECOM) in co-ordination with Tank Automotive Command (TACOM). The RWR will form part of the Vehicle Integrated Defense System (VIDS) which is currently under development by the United States Army

The RWR system will detect threats automatically, determine the direction of arrival, characterise the nature of the threat and output commands that will ultimately trigger countermeasure devices.

The AIL Systems RWR will use a rapid sorting technique which has been successfully demonstrated on earlier programmes. It will also include hardware and software from the Modular Electronic Warfare Pre-Processor (MEWPP) which was developed by Digital Engineering.

Status: Under development for the United States Army

Manufacturer: AIL Systems Incorporated, Advanced Technology Systems, Commack Road, Deer Park, New York 11729, USA.

Loral Hardhat ATGW Decoy System

Development/Description

The Hardhat anti-tank guided missile countermeasure system was developed as a private venture by Loral Electro-Optical Systems for installation on a wide range of vehicles, tracked and wheeled, to improve their battlefield survivability

Hardhat is a multi-threat jammer which protects the vehicle against a wide range of ground- or air-launched anti-tank guided missile threats.

It is normally mounted on the roof of the vehicle and operates directly from the vehicles 28 V DC power, either in an open-loop stand-alone mode or integrated with other vehicle warning and/or self-protection equipment.

In the standard version the display and control box would normally be positioned near the vehicle commander.

As the Hardhat system has a field-of-view of only 60°, one or more jammers would normally be fitted to cover the required protection zones.

As an option, the roof-mounted system can be provided with external armour plate and an optional gimbal system to allow slewing in response to threat warning sensor inputs. Another option is a pop-up optical assembly for enhanced survivability

60°

20.41 kg (without armour)

SPECIFICATIONS

FIELD-OF-VIEW horizontal vertical

WEIGHT JAMMER SIZE

305 mm height 457 mm width 508 mm depth

Status: Development. During the 1991 Middle East conflict the US Army purchased some 2600 new missile jammers under the designation of VLQ-6 (or the Missile Countermeasures Device) developed by Lockheed Sanders and Loral. It is understood that these were installed on a number of Bradley infantry fighting vehicles during the conflict.

Manufacturer: Loral Electro-Optical Systems, 300 North Halstead Street, PO Box 7101, Pasadena, California 91109, USA.

Telephone: (818) 351 5555 Fax: (818) 351 5081



Bradley fighting vehicle with Loral Hardhat device mounted on roof of vehicle

Santa Barbara Research Center Laser Warning Sensor

Development/Description

Using its extensive experience in electro-optical systems, the Santa Barbara Research Center has developed a simple lightweight laser warning sensor.

This was originally developed for airborne applications and has already been tested on an F-4 aircraft at Eglin Air Force Base, a flight series on a National Guard A-7 and several other flight tests. Static tests of the sensor have been carried out at the Wayside Test Range, Fort A P Hill and Wright Patterson Air Force Base and other locations. Performance reliability and false alarm projection have been verified.

The laser warning sensor is now being offered for application to ground systems, including armoured vehicles.

Each sensor head contains the power conditioning circuitry, optical elements, a detector and all signal processing components.

The sensor output is a serial data stream describing the position of the threat, the amplitude of the signal and the repetition rate of the pulses.

In an MBT application, for example, two sensor heads are required to protect the vehicle, each covering an arc of 190° in azimuth and ±55° in elevation.

A wide-angle lens collects laser radiation from within a 190° field-of-view and directs it to one element of an eight element detector array.

The signal from the detector array is preamplified and processed with a pair of semi-custom integrated circuits developed specifically for this application.

The latched digital output of the processing circuit is read by a microcontroller which generates the threat data word and transmits it over a serial line to an external device.

An integral LED is used to implement a built-in test of the sensor every five minutes. This information, together with other diagnostic data are also sent to the external device.

SPECIFICATIONS FIELD-OF-VIEW

WAVELENGTH RANGE

ANGULAR RESOLUTION

PULSE WIDTH RANGE OF FULL

SENSITIVITY
MAX PULSE REPETITION
FREQUENCY THAT CAN
BE MEASURED
SIZE
WEIGHT
POWER REQUIREMENT
OPERATING TEMPERATURE

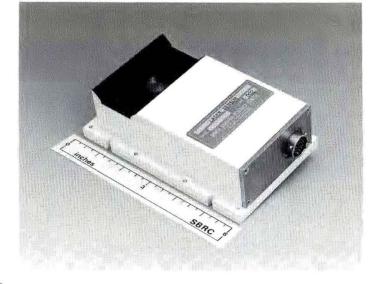
Status: Prototype systems.

OUTPUT FORMAT

190° in azimuth, ±55° in elevation (expandable to ±85°) senses well known laser threats such as Nd:YAG, Ruby, GaAs and doubled Nd:YAG adequate to cue evasive action and/or countermeasures optimised to detect laser rangefinders, designators and beamriders

5 kHz 51 × 76 × 126 mm 0.8 kg 24/32 V DC, 3 W

-55 to +70°C (tested to -20°C) RS-232 (5 byte data words)



Santa Barbara Research Center Laser Warning Sensor (LWS)

Manufacturer: Santa Barbara Research Center, 75 Coromar Drive, Goleta, California 93117, USA.

Telephone: (805) 562 4127 Telex: 910 334 1885 HACSBAR

YUGOSLAVIA (SERBIA/MONTENEGRO)

Laser Irradiation Detector

Development/Description

This second generation laser warning device, the Laser and Infra-red Irradiation Detector (LIRD), has been developed for installation in both vehicle and shipborne applications to provide a warning signal when the platform is irradiated by a laser rangefinder, laser illuminator or infra-red searchlight.

In addition to detecting direct illumination it also detects indirect, for example from nearby objects, ground or sea reflected illumination.

The system detects both pulsed and continuous wave radiation in the 0.66 to 1.1 μ m wavelength band and is thus able to detect all types of ruby, GaAs and neodymium lasers.

The LIRD set consists of a detector head, display box and interconnecting cables.

The detector head, which is normally mounted on the tank or AFV turret, includes 12 detectors with corresponding filters for the detection of direct laser or infra-red illumination, and one detector with corresponding optical system for the detection of indirect laser illumination.

The detectors for direct illumination are positioned in the detector head in such a way that together with the processing electronic circuitry they divide the hemisphere around the vehicle into $24 \times 7.5^{\circ}$ wide sectors.

The detector for indirect illumination of laser rangefinders or laser illuminators detects only irradiation in the 1.064 $\pm\,0.015~\mu m$ wavelength range. Its field-of-view is, due to the special design of the optical system, such that it protects the area around the vehicle through 360° in azimuth and about –13 to –7° in elevation, in a perimeter of 20 m.

The display box mounted in the turret at the commander's station includes most of the logic circuitry LED displays, acoustic warning signal and generator and power supply. The display consists of 28 LEDs of which 24 are intended to display the detection of incoming irradiation and three for indication of the type of illuminating source (LD = laser rangefinder, LOC = laser illuminator and IC = infra-red searchlight). All of these diodes emit red light.

The 28th diode indicates the direction of the gun barrel and at the same time serves as an on/off indicator. The light emitted by this diode is green when the supply voltage is of the correct value and turns to red if the supply voltage drops below the permitted value (12 V).

In addition to the LED displays the front panel also has the on/off switch, self-test button, mode selector switch and the last irradiation data recall switch.

The LIRD has two modes of operation, day or night, which can be selected with the mode selector switch. In the day mode the system does not respond to CW infra-red searchlight illumination and when this mode is chosen an LED located in the mode selector switch is turned on. The system responds to CW infra-red searchlight illumination at night.

The signal processing circuitry is designed in such a way that it is possible at any time to recall to the display all data of the last detected irradiation. Optical filters are incorporated into the detector systems for the

detection of direct irradiation protection against solar and searchlight glints and against gunfire flashes.

An optical narrowband filter incorporated into the optical system for detecting indirect irradiation, performs the same function in that system.

Upon detection of a single laser rangefinder, a series of laser pulses form a laser illumination or CW irradiation from an IR searchlight, the warning signal processing circuitry sends data on the direction and type of illumination to the display box, where the correct displays and acoustic warning signal are activated.

Duration of the acoustic signal, injected into the crew headset, and the visual signal is approximately two seconds unless otherwise specified by the user.

SPECIFICATIONS

Detector head-direct detection TOTAL FIELD-OF-VIEW

NUMBER OF DETECTORS SINGLE DETECTOR FIELD-OF-VIEW

DIAMETER OF ENTRANCE PUPIL OPTICAL BANDWIDTH INDIRECT DETECTION FIELD-OF-VIEW

NUMBER OF DETECTORS DIAMETER OF ENTRANCE PUPIL OPTICAL BANDWIDTH

Display box

HORIZONTAL RESOLUTION NUMBER OF RESOLUTION SECTORS NUMBER OF IRRADIATION SOURCE TYPE RESOLUTION

DURATION OF WARNING SIGNALS

OPERATING VOLTAGE

360° in azimuth -20 to +60° in elevation 12 (PIN diodes)

45°azimuth 80° elevation

23 mm 0.66 to 1.1 μm

360° in azimuth -13 to -7° in elevation 1 (available diode)

 $1.064\pm0.015~\mu\text{m}$

15 (02-50)

50 mm

24

3 (laser rangefinder, laser illuminators, IR searchlights)

acoustics 4 s visual 8 s 12 to 30 V

Status: Production.

Contractor: Federal Directorate of Supply and Procurement (SDPR), PO Box 308, 9 Nemanjina Street, Belgrade, Yugoslavia (Serbia/Montenegro). Telephone: 621 522 Telex: 11360/11541 Fax: 635 702

Fire Detection and Suppression

AUSTRIA

Intertechnik MFS Engine Compartment Fire Extinguishing System

Development/Description

The MFS (Motorraum-Feuerlöschanlage) engine compartment fire extinguishing system has been designed for installation in tracked and wheeled armoured vehicles. It detects and automatically extinguishes fires starting in the engine compartment.

It essentially consists of a central control unit, up to six mutually independent sensors and one or two mutually independent extinguishing containers each with a solenoid-operated opening valve.

The microprocessor in the central control unit carries out constant self-testing of the system and any faults that occur are reported via a display readout.

SPECIFICATIONS

OPERATING VOLTAGE 12 V or 24 V EXTINGUISHING AGENT Halon 1211

Status: Development complete. Ready for production.

Manufacturer: Intertechnik GmbH, A-4040 Linz, Industriezeile 56, Postfach

100, Linz, Austria.

Telephone: (0732) 27 73 91 Telex: 02 - 1522 his a

Intertechnik EFS Explosion Suppression System

Development/Description

The EFS (Explosionsunter-drückungssystem) explosion suppression system has been developed by Intertechnik to increase the battlefield survivability of armoured fighting vehicles.

According to Intertechnik, when an armoured vehicle is fitted with the EFS explosion suppression system, hydrocarbon explosions are both recognised and extinguished very rapidly.

Key features of the system can be summarised as a high degree of protection against false alarms, auto-test facility for complete system with malfunctions being indicated on the display, the ability to recognise hydrocarbon explosions and penetration by projectiles and extinguish the explosion within a maximum of 150 ms, up to five non-independent recognition

sensors, two independent electromagnetically triggered extinguishing units and stand-by electric power supply from a buffer accumulator.

SPECIFICATIONS

REACTION TIME 10 ms
TOTAL EXTINGUISHING TIME 100-150 ms
OPERATING VOLTAGE 12 V or 24 V
EXTINGUISHING AGENT Halon 1301

Status: Development complete. Ready for production.

Manufacturer: Intertechnik GmbH, A-4040 Linz, Industriezeile 56, Postfach 100, Linz, Austria.

Telephone: (0732) 27 73 91 Telex: 02 - 1522 his a

ISRAEL

Spectronix Automatic Fire and Explosion Detection and Suppression System (AFEDSS)

Developmen

The Automatic Fire and Explosion Detection and Suppression System (AFEDSS) was developed by Spectronix to meet the requirements of the Israeli Defence Force following their experiences in the 1973 Middle East war when many Israeli tank crews were killed or injured when their vehicles caught fire following penetration of the tank armour by High Explosive Anti-Tank (HEAT) and kinetic energy weapons.

The main Israeli Defence Force requirements were to increase crew and vehicle survivability and to provide for an add-on modular design, enabling interchangeability and commonality between vehicles.

Following extensive trials, series production of the AFEDSS commenced in 1981, and the Israeli Defence Force now installs it on all new production Merkava MBTs. It is also being backfitted to earlier production Merkavás as well as Centurion, M48 and M60 MBTs.

The AFEDSS has also been exported and other vehicle types that it has been installed in include the Leopard 1 and former Soviet T-series MBTs, the M113 APC and M109 155 mm self-propelled howitzer.

Spectronix Crew System

The Crew System is an automatic, instantaneous, detection, control and suppression system with a peace and war mode of operation whose primary function is to protect the crew from secondary effects of a projectile penetration, namely, restricting skin burns to first degree levels and preventing lung damage which results from pressure shock. The system detects and suppresses an explosion within 100 ms. It consists of a number of key subsystems:

- (1) Detection subsystem. This consists of a suitable number of optical fire detectors which effectively cover the entire volume to be protected. It is capable of detecting HEAT or kinetic energy round penetration within 2 ms, as well as fuel fires and vapour explosion, without false alarms
- (2) Logic and control subsystem. This provides automatic control and status indication of all components, has a dual operation mode selection (normal/combat), a manual override capability, automatic back-up in case of cylinder or system malfunction and built-in testing features



Key components of Spectronix AFEDSS Crew System

(3) Dispersion subsystem. This consists of a suitable number of Halon 1301 cylinders with a double shot capacity, capable of instantly discharging their contents and effectively suppressing fire or explosions.

Spectronix Engine System

The Engine System is based on the need for an automatic, reliable rapid durable detection, control and extinguishing system whose primary duty is to prevent damage or destruction to the engine and transmission. It consists of the following subsystems:

- (1) Detection subsystem. This is a thermistor type overheat wire detector which detects rises and falls in temperature and is employed to ensure full coverage of the engine compartment. The detector has two levels of detection, an overheat level where indication warnings are given that the preset overheat level has been reached and the higher fire condition where the system automatically activates the dispersion subsystem
- (2) Logic and control subsystem. This provides automatic control and status indication of all components, has a manual override capability and automatic back-up in case of cylinder or system malfunction and has built-in testing features. The system features dual shot performance. The second shot is manual and shuts down the engine (in order to extinguish engine fed fires). Since it is a manual activation it needs a command decision to shut down the engine in combat situations, in contrast to automatic shut down systems
- (3) Dispersion subsystem. This consists of a suitable number of Halon 1301 cylinders, capable of instantaneously discharging their contents through piping and discharge nozzles to the various areas in the engine compartments.
 - As an option the system can also incorporate various add-on features some of which are:
- (a) external independent manual activation
- (b) activation of the vehicle's ventilation
- (c) audio or audio/visual alarms
- (d) systems energiser unit (for vehicle storage situations).

Status: In series production since 1981 for Israeli Defence Force and many other undisclosed customers. Thousands of systems are in field use.

Manufacturer: Spectronix Ltd, 18 Rival Street, IL-67778 Tel Aviv, Israel. Telephone: 972 3 371113 Telex: 33353 SAFE IL Fax: 972 3 377180

UNITED KINGDOM

Kidde-Graviner Crew Bay Explosion, Detection and Supression System

Development

The Crew Bay fuel explosion/fire protection system was developed in the 1970s to increase AFV crew survivability in combat by detecting and suppressing fires and explosions caused by the rupturing of fuel tanks and fuel and hydraulic lines.

The Crew Bay System is able to detect and recognise an explosion/fire within 2 to 3 ms of its inception and effect complete suppression in about 100 ms by the use of infra-red sensors and rapid acting high-rate discharge suppressors.

In addition to being installed in new build vehicles, it can also be retrofitted into older vehicles.

As well as the UK, the system is manufactured in Germany by Deugra for German built vehicles such as the Leopard 2.

Kidde-Graviner's operations in the United States are handled by Walter Kidde Aerospace Inc.

The contract awarded by the Jordanian Armed Forces in 1987 is now complete with installations undertaken in country to all 274 Royal Ordnance built Khalid MBTs as well as the 293 Tariq modernised Centurion MBTs. The ENGESA EE-11 Urutu (6 \times 6) APCs ordered for police use also have systems specified. This was the largest export order for Crew Bay placed at the time but since then further export sales have been made including part licensing to an unnamed country in the Far East.

Crew Bay is installed in the Challenger Armoured Repair and Recovery Vehicles designed and developed by Vickers Defence Systems to meet the requirements of the British Army and has also been installed in the Brazilian EE-T1 Osorio MBT, EE-11 Urutu APC and the M41 light tank.

Description

The Crew Bay System senses infra-red radiations of a hydrocarbon flame characteristic of exploding and burning fuel, but does not react to similar radiations occurring in a battlefield environment. The detectors are coupled to a control unit which automatically actuates one or more high-speed suppressors which deploy non-toxic concentrations of suppressant within the crew compartment to suppress a fuel explosion/fire before catastrophic conditions result.

The Crew Bay detector contains the sensors and all of the logic circuitry. The sensors detect the infra-red radiation characteristics of a hydrocarbon explosion/fire with the logic differentiating between the signature of a hydrocarbon flame and other non-fire stimuli.

The standard control unit has been engineered to accommodate up to



Kidde-Graviner Crew Bay detector unit

four detectors and the microprocessor-based design allows manufacture of either single or dual shot suppression systems.

As the electrically actuated valves on the suppressors require only minimum current to operate them, enough electrical energy can be stored in the control unit to ensure that the suppressors can be activated in all vehicle conditions.

The control unit provides stabilised power and line monitoring for detection and suppression subsystems.

The 3.2 kg high-speed suppressor bottle with electrically actuated valve discharges its liquid contents within 75 to 80 ms. This is achieved by storing suppressant at high pressure and by using a high-speed non-explosive pyrotechnic piston actuator to release the seal supporting mechanism, so allowing the pressure to open the valve. The suppressant then has an unobstructed path through the nozzle directly into the fire zone.

In June 1988 a further development of the two-shot Crew Bay Control unit was announced by Kidde-Graviner. This is designated the SC15 and has been designed for use with a Crew Bay system consisting of up to four infra-red detectors and six suppressors. Correct vehicle configuration is automatically selected by connecting the vehicle cable harness. Configurable for as many as 15 different vehicle types, SC15 incorporates a BITE function and features an eight digit alphanumeric display.

The SC15 control unit has a BITE function offering several major features all of which are designed to provide constant monitoring of the Crew Bay system, thereby ensuring that the crew is fully informed on any malfunction.

System fault conditions are indicated by a yellow fault lamp and an appropriate coded message on the alphanumeric display panel located on the front of the control unit.

The control unit may be switched between a number of operational modes and in normal conditions, that is with no faulty components in the system, the alphanumeric display will be blank and the fault lamp off.

In all modes of operation it is possible by use of a press-to-test switch, mounted on the control unit to:

- (1) Check the fault indicator lamp integrity
- (2) Test all segments of the alphanumeric display for correct operation
- (3) Identify the vehicle installation on the alphanumeric display for correct operation
- (4) Identify the mode of system operation
- (5) Display the appropriate code for each faulty component in the system on the alphanumeric display.



Kidde-Graviner Crew Bay control unit

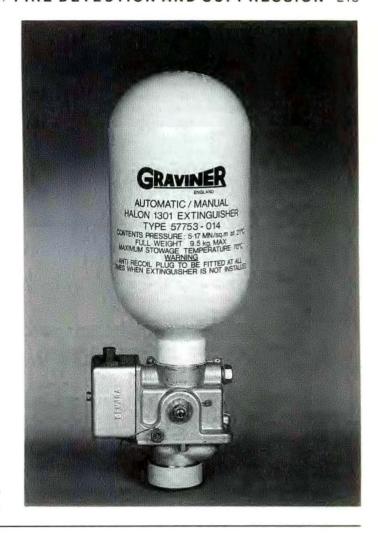
Status: In production. In service with Germany, Jordan, the Netherlands, Switzerland and the United Kingdom. By early 1993 over 4000 systems had been completed with production continuing. Work is currently underway to evaluate alternative and replacement 'ozone friendly' extinguishing agents for military vehicle application.

Manufacturer: Kidde-Graviner Limited, Poyle Road, Colnbrook, Slough,

Berkshire SL3 0HB, UK.

Telephone: (0753) 683245 Telex: 848124 GRAVIN G

Fax: (0753) 685126



Kidde-Graviner 3.2 kg high-speed suppressor discharges liquid phase of its contents through an electrically operated valve within 75 to 80 ms

Kidde-Graviner Engine Bay Fire Detection and Suppression System

Development/Description

Engine Bay has been designed by Kidde-Graviner to detect and suppress engine fires caused by fuel leaks or overheating of the engine. Some 35 000 vehicles in 40 countries have been fitted with Engine Bay systems. A recent example is the Vickers Shipbuilding and Engineering Limited 155 mm AS90 now in service with the British Army.

A typical Engine Bay system consists of the control unit, normally mounted at the driver's position, FIREWIRE sensors routed round the whole engine compartment, spray pipe running around the whole engine compartment with nozzles at predetermined points and extinguisher bottle which is normally mounted outside the engine compartment.

HSRS (High Speed Resetting Switches) point detectors or FIREWIRE continuous fire and overheat detectors are installed within the engine bay with suppression being achieved by high rate discharge extinguishers.

Once the temperature is caused to rise above the preset level, a warning signal is given. The automatic systems can be activated immediately.

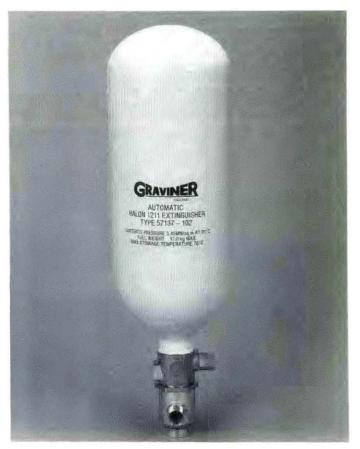
A control unit can be wired to ensure that automatic extinguisher operation is always activated when the vehicle is parked with the master switch off, so

EXTINGUISHERS UNSERVICEABLE 51653-189 5 No.168

Control panel for Kidde-Graviner Engine Bay system

ensuring a fully functioning system is always available when the vehicle is left unattended.

The FIREWIRE element consists of a stainless steel capillary approximately 1.8 mm in diameter which houses a central electrode. This electrode is coaxially located by temperature sensitive semi-conductive materials giving a construction that is both light in weight and rugged.



Engine Bay automatic extinguisher

The installation in the engine bay is fireproof and resettable. It is equally important to provide a "Fire-out" signal so that the crew does not bale out unnecessarily.

Kidde-Graviner manufactures a range of single and dual-head fire extinguishers for use with FIREWIRE and HSRS detection systems. Electrically operated pyrotechnic devices open the extinguisher valves. A predetermined number of bottles can be linked through a control unit to give a tailor-made system to meet vehicle installation requirements, with spray pipes being used to carry the extinguishant to the discharge points in the engine or transmission bay.

Status: In production. In service with some 40 countries worldwide. By early 1993 more than 35 000 FIREWIRE systems were in service, of which about 800 use the latest version of the control unit.

Manufacturer: Kidde-Graviner Limited, Poyle Road, Colnbrook, Slough, Berkshire SL3 0HB, UK.

Telephone: (0753) 683245 Telex: 848124 GRAVIN G

Fax: (0753) 685126

Kidde-Graviner Integrated Control Unit

Development/Description

Shown for the first time in 1990 was the new Integrated Control Unit (ICU) which was developed as a private venture by Kidde-Graviner for installation in armoured personnel carriers and other armoured vehicles without a

The ICU monitors both the crew and engine bay protection systems which combine Crew Bay infra-red detection and engine bay continuous fire and overheat detection. In addition the unit will provide automatic extinguishing and suppression for both areas.

It has been designed to accept signals from three infra-red detectors and one loop of continuous sensing element and is provided with a system of indicators showing operational status. It continuously checks the condition of the detectors, sensing element, suppressor and extinguishers.

Status: Prototype systems. Not yet in production or service.

Manufacturer: Kidde-Graviner Limited, Poyle Road, Colnbrook, Slough, Berkshire SL3 0HB, UK.

Telephone: (0753) 683245 Telex: 848124 GRAVIN G

Fax: (0753) 685126

UNITED STATES OF AMERICA

Santa Barbara Research Center Explosion/Fire Protection System

Development

Santa Barbara Research Center (SBRC), a wholly owned subsidiary of Hughes Aircraft Company, has been involved in the development, testing and manufacture of high-speed optical explosion/fire sensing and suppression systems since 1969 in co-operation with various US and foreign military programmes. In addition to armoured vehicles these programmes include aircraft, helicopters and ships. The first US production vehicle to be fitted with this system was the General Dynamics, Land Systems Division, M1 Abrams MBT.

These infra-red optical sensors with millisecond response plus thermal sensors provide the best protection for engine and auxiliary power unit spaces against both explosive fires and slow-growth fires. They also contain the ability to detect quickly overheat conditions in these spaces

The SBRC Fire Sensing and Suppression (FSS) Systems product line is dedicated completely to developing and producing explosion protection systems which are highly reliable, of high quality and totally dependable for protection of life and equipment.

Santa Barbara Research Center now has systems in quantity production for the M1 Abrams, M2/M3 Bradley Fighting Vehicle, South Korean Type 88, US Marine Corps AAV7A1 armoured amphibious assault vehicle, LAV-25 (8 × 8) vehicle and variants, Taiwan M48H 105 mm MBT, C-5 heavy lift transport aircraft and the Italian B1 Centauro (8 x 8) 105 mm armed vehicle.

These programmes account for the manufacture of more than 100 000 sensor system components, which are contained in over 16 000 vehicle sets of production hardware, plus additional test and support equipment and spares

The SBRC system proved to be effective on the battlefield during Operation Desert Storm, being credited with saving several lives of crew members of M1 MBTs and Bradley Fighting Vehicles under hostile fire.

Description

The Santa Barbara Research Center Automatic Explosion/Fire Sensing and Suppression (AEFSS) System is an infra-red Dual Spectrum optical system capable of detecting hydrocarbon fuel fires and explosions within tanks and other armoured fighting vehicles. The system is integrated with a compatible fire suppression system, utilising high-speed valves and cylinders filled with the appropriate extinguishing agent. Complete sensing and suppression of an explosive fire can be achieved in less than 200 ms. The SBRC system is designed and qualified to meet the performance specifications developed by the United States Army, the United States Marine Corps and aircraft manufacturers.

The basic Dual Spectrum sensing system responds to explosive hydrocarbon type fires in under 3 ms with almost complete false alarm immunity. To produce an output trigger signal to the suppression system, the sensors must detect radiation within two infra-red spectral bands, each with radiation levels above pre-established thresholds.

The Dual Spectrum sensing systems are used primarily with high-speed cylinder/valve suppression systems. The cylinder/valve assemblies used for these applications typically contain Halon 1301, super pressurised with dry Nitrogen to ensure rapid discharge over a wide range of temperatures. However, other types of extinguishing agents are used depending on the actual application.

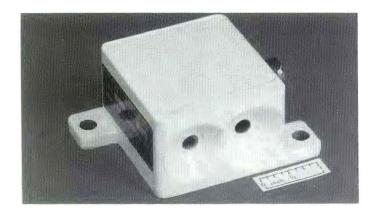
Valve opening times vary from about 2 ms for squib or protractor type valves to about 7 ms for solenoid type valves. The entire cylinder is discharged in 60 to 90 ms.

Sensors

SBRC Dual Spectrum sensors operate according to a patented concept which monitors near and far infra-red spectral bands within pre-established thresholds to confirm a hydrocarbon fire and to exclude false alarm stimuli. SBRC infra-red optical sensors function effectively in engine compartments with little degradation from accumulation of dirt or oil on the detector windows

Model PM-3 is the basic SBRC Dual Spectrum fire sensor which is standard equipment on the M1/M1A1 Abrams, M48H and B1 Centauro and Type 88 production MBTs. This sensor has a 90° optical field-of-view and an operational temperature range from -67°F (-55°C) to +257°F (+125°C).

The Model PM-34 provides additional discrimination capability which prevents the suppression system from activating on the energy from KE or HEAT rounds when no hydrocarbon explosion or fire occurs. This equipment



Santa Barbara Model PM-3C sensor



Santa Barbara Model PM-34C sensor

is standard on the M2/M3 Bradley Fighting Vehicle and has been procured by the US Marine Corps for the AAV7A1 armoured amphibious assault vehicle. This has the same optical field-of-view and operational temperature range as the PM-3 model.

The Model PM-34CBEH is the newest advanced unit which incorporates the false alarm immunity and discrimination features of the other fire sensor models plus Built-In Test Equipment (BITE) and integral fast response optical heat sensing capability. This sensor has the same optical fieldof-view and operational temperature ranges as the previous models

The PM-5 is a stand-alone driver's module which is powered by standard 12 V (or 24 V) power sources. It can operate one extinguisher or may be interfaced with other PM-5s and extinguishers for larger zone sensing and suppression coverage. It has a 90° optical field-of-view and will operate over the temperature range of -67 to +212°F.

Control electronics

These provide the logic and control functions rapidly and reliably to process inputs from sensors, perform necessary analysis and comparisons and generate signals needed to activate extinguishers and status indicators. System control panels are tailored to each vehicle's operational needs for crew alerts and status indicators, plus controls for manual system activation.

Extinguisher bottle and valve assembly

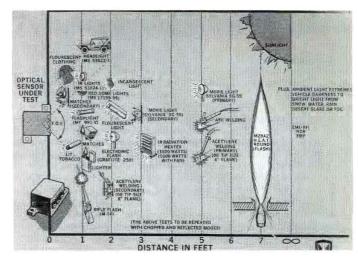
The combination of non-shatterable steel bottles and fast acting valves, which are activated by either solenoid or protractor, provide the mechanism to store and release the fire suppression agent. Agent leakage rates of less than one ounce per year ensure availability of the fire extinguisher when

Other components

Electrical wiring and components mounting brackets comprise the remainder of the system. They are designed to ensure reliable and durable performance in the vehicle operational environment which typically is characterised by vibration, shock and rugged use.

SBRC also manufactures test equipment for checking the Dual Spectrum infra-red sensors and the system as a whole.

Status: In production. In service with South Korea (Type 88 MBT), US Army (M1/M1A1, M1A2, M2 and M3) and US Marine Corps AAV7A1, LAV and Italy (B1 Centauro). It has also been installed in a number of other vehicles for trials purposes including the S-tank, M47 and M60 MBTs, M113, HSTV-L, AAI automotive test rig, M48 MBTs (Cadillac Gage Textron



False alarm susceptibility tests (Class A discriminatory sensor system) for Santa Barbara optical sensor

and General Dynamics, Land Systems Division), M48H (Taiwan)), Leopard 2, AMX-10, AAI HWSTD, Italian C1 and VCC 80, US LAV-105 (prototype). and South Korean BIHO

Production quantities:

venicle	Quantity (including spares
M1/M1A1/M1A2	8100+
M2/M3 Bradley	6300+
ROC M48	350+
Type 88 ROK (K-1)	833
AAV7A1	1475
B1 Centauro	400
LAV	1117

Manufacturer: Santa Barbara Research Center, 75 Coromar Drive, Goleta, California 93117, USA

Telephone: (805) 562 4127 Telex: 910 334 1885 HACSBAR

Marotta Automatic Explosion Suppression System

Development/Description

Marotta Scientific Controls started development of this valve design concept in the early 1970s and following extensive trials, including actual field explosion tests carried out in military vehicles, it entered volume production for a wide range of civil and military applications on land, sea and air.

The qualification programme included field and laboratory performance tests including actuation before, during and after storage at temperatures of -65°F (-54°C) and +165°F (+74°C) as well as shock and vibration simulating tracked vehicle operating conditions.

According to Marotta Scientific Controls the MV121KJ-1 is the world's first solenoid actuated Halon 1301 valve qualified for military suppression applications. It is reusable/rechargeable, has a millisecond response time, is solenoid actuated, has a long storage life and is qualified for installation in a wide range of systems including the M1 and M60 MBTs, M2 Bradley IFV and the AAV7A1 amphibious vehicle. Explosion suppression valves have been installed in both crew and engine compartments of armoured vehicles.

The system will inhibit chemically explosive flame propagation of volatile gas and liquid including petrol, diesel, hydraulic oil, alcohol, solvents, methane, propane and town gas. Other Halon and CO2 suppressants, although not breathable, are compatible with this design series and are suitable for unmanned engine room, machinery space and other remote locations.

The design of the valve is such that it can be integrated into systems that use various types of sensors to detect different explosive or fire conditions. Optical, thermistor, ion or wave sensors may be used separately or in combination

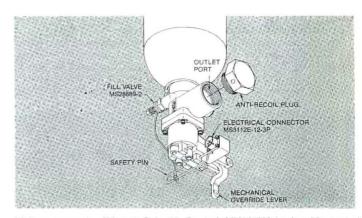
The MV121KJ-1 units are supplied complete with pressure gauge, safety burst disc, anti-recoil plug, non-shatterable cylinder, Halon and nitrogen charge, threaded discharge for nozzle or distribution system, fill valve for recharge, manual release with safety pin, electrical connector and weight record tag. Options include a flow indicator and a low pressure switch.

The solenoid valve allows for repeated use for operation, training and test purposes.

The Marotta explosion valve can be supplied with different size cylinders for optimum suppression concentration, these sizes are 2.3 kg, 3.2 kg and 4.6 kg

Status: In production. Installed on a number of armoured vehicles.

Manufacturer: Marotta Scientific Controls Inc., 78 Boonton Avenue, PO Box 427, Montville, New Jersey 07045, USA. Telephone: (201) 334 7800 TWX: 710 987 8358



Main components of Marotta Scientific Controls MV121KJ-1 solenoid actuated Halon 1301 valve system

Pacific Scientific HTL/Kin-Tech Division Automatic Fire Extinguishing Systems (AFES)

Development

The US Army implemented a research and development programme which resulted in two specifications being issued, ATPD-2070 Edition 6A and ATPD 2071 Edition 6A, for key components of an advanced state-of-the-art automatic fire detection and suppression system.

HTL/Kin-Tech Division of Pacific Scientific (HTL) subsequently developed a complete crew and engine compartment protection system which has proven itself through extensive 'live fire' testing on armoured vehicles against a large variety of anti-armour weapons. HTL has qualified this system for use with the US Army and is now supplying complete systems for such vehicles as the M992 Field Artillery Ammunition Support Vehicle (FAASV). This system is also in use internationally on such programmes as the South Korean Type 88 MBT.

In 1981, as the US Army was developing requirements for an advanced state-of-the-art automatic fire detection and suppression system for their fleet of armoured fighting vehicles, HTL began development of a system to meet the new specifications.

In 1984, HTL won the first production contract for systems meeting these latest specifications (ATPD-2070 Edition 6A and ATPD-2071 Edition 6A) for use on the M992 Field Artillery Ammunition Support Vehicle (FAASV). The system was qualified through the most extensive 'live fire' testing program ever conducted on this type of system by the United States Army at Aberdeen Proving Grounds. The United States Army has purchased 675 FAASVs to date, all with HTL systems in both the engine compartment and the crew/ammunition compartment.

HTL also provides earlier technology AFES components to the US Army M1 MBT and M2/3 Bradley programmes. HTL has also supplied components for qualification testing to the Bradley AFES Upgrade programme. The US Army has decided to upgrade the automatic fire extinguishing system in the crew compartment of the Bradley with components meeting the latest specifications such as those used on the M992 FAASV. ATPD-2070 Edition 6A and ATPD-2071 Edition 6A have now been converted to MIL-M-62545A, MIL-M-62546A and MIL-V-62547A.

Description

The HTL AFES is actually made up of two subsystems, one subsystem to protect the crew compartment and a separate subsystem to protect the engine compartment, plus a manual activation system.

There are two principle reasons the AFES is divided into two subsystems. Firstly, the fire threats are very different in each compartment. The primary threat in the crew compartment is exploding fuel or hydraulic fluid initiated by an armour penetration. Even a small amount of fuel or hydraulic fluid, such as from a severed hydraulic line, when atomised and ignited by a penetrating munition, will produce an explosion that, if not suppressed, will cause over pressure high enough to injure or kill the vehicle crew and will be followed by a fire that can destroy the vehicle. The secondary threat in the crew compartment is of small fires which result from electrical short circuits and poor vehicle maintenance.

To counter these threats, HTL has designed a system that can react to the start of an explosive fire and disperse fire suppressing agent so that over pressures are controlled before they reach injury causing levels and the fire is extinguished before it can cause serious injury to the crew and damage to the vehicle.

Since speed of detection is critical, HTL selected an array of three optical sensors for each detector assembly. Utilising a patented logic concept, the start of explosive fires can be detected within a few milliseconds. Employing three sensors has allowed HTL to achieve much greater false alarm immunity than earlier two sensor detectors. This was verified by the US Army testing against 28 potential false alarm sources.

The patented detection logic and the use of three sensors has allowed HTL to advance the state-of-the-art by achieving the first truly discriminating detector, that is a detector which can distinguish between an armour penetration that results in an explosion and/or fire and one that does not.

This has become an important requirement as the accuracy and firing

rates of anti-armour weapons have improved. Statistics show that if a vehicle has been hit once, a second hit is very likely if the first does not destroy the vehicle. Many times a penetrator or the plasma jet will simply pass through the vehicle not striking fuel, hydraulic fluid or ammunition. If the AFES can distinguish between this event and one where an explosion and/or fire occurs, the fire extinguishing agent can be saved for when it is really needed.

Another feature of the HTL system and a requirement of the latest specification is a second shot capability. This feature is also to reduce the threat of a second hit. There is a second set of fire extinguishers which are discharged automatically if a second explosion and/or fire is detected.

A third system feature to reduce the threat of a second hit in the system sends a signal which turns on the vehicle ventilator in the exhaust mode to vent the smoke and fire extinguishing agent after the fire is extinguished. This means the crew can stay in the vehicle continuing to fight and manoeuvre the vehicle to avoid or defeat the threat.

HTL has developed a fast reacting solenoid actuated valve which opens in a few milliseconds and rapidly discharges extinguishing agent. The US Army, through extensive live fire testing, has found Halon 1301 to be the most effective non-toxic extinguishing agent available. A distribution nozzle, which has been developed and proven through live fire testing is utilised with each valve to achieve adequate extinguishing agent concentration throughout the protected compartment. The extinguishing agent capacity of the valve and bottle also is tailored to the unique requirements of each vehicle.

Other key features of the HTL Crew Compartment AFES are extensive Built-In-Test Equipment (BITE) and minimum maintenance requirements. Each time vehicle power is switched on, a complete test sequence is initiated. The test includes an optical check of each detector. This is done by simulating a fire. Each detector has an externally mounted Light Emitting Diode (LED) that simulates a fire to the sensors which determines if the detector can see a fire (or whether the sensors are dirty), can process the input and issue a fire signal to control electronics. The control electronics are tested to assure a fire signal can be processed and each of the valve solenoid driver circuits can actuate a valve. Thus, before the vehicle is driven off, the crew is assured they have a properly functioning AFES. The system also continually monitors the pressure in the fire extinguishers and the continuity of all the electrical cables. If a system problem occurs, a fault light is illuminated and an LED illuminates identifying the malfunctioning module(s) on the crew interface panel. No separate test equipment is required to verify system performance.

To deal with small secondary threat fires typically resulting from electrical shorts or poor maintenance, the HTL system has a small fire warning. A fire warning light flashes and an audible warning signal is sent to the crew. This gives the crew the option of using hand-held extinguishers to suppress the fire thus saving the system extinguishers for combat. The crew can also discharge the system by a guarded switch on the crew interface panel.

Explosion is not a threat in the engine compartment since they are vented and separated from the crew compartment. Therefore speed of detection becomes secondary to ruggedness. Optical detection is not successful in engine compartments as the optical sensors quickly become dirty and viewing angles are very limited due to the cramped nature of the compartment. The HTL system therefore utilises a loop of thermal sensing wire. The flexible wire allows routing to all the potential fire hazards (for example fuel lines, disc brakes, fuel cell and floor of engine compartment). The wire is not affected by dirt, fuel, hydraulic fluid or water. Again two levels of warning are provided. If a small slow growth fire occurs, the crew is warned as they are with the crew AFES allowing them the options of extinguishing the fire with hand-held extinguishers or discharging the system extinguishers by guarded switch on the crew interface panel. If large vehicle-threatening fire occurs, the system automatically extinguishes it.

The same fast reacting rapid discharge Valve and Bottle Assemblies that are used in the crew compartment are also used for the engine compartment to simplify logistics. They are piped into the engine compartment into a distribution system which discharges the Halon 1301 extinguishing agents so that the fire threat areas are covered and fires are extinguished. Extensive testing by the US Army has demonstrated this system's ability to detect and extinguish fires, even with the engine running at maximum speed and the



HTL Crew Compartment Test and Alarm Panel assembly (CCTAP)



HTL Optical Fire Sensor Assembly (OFSA)

cooling fans operating with no damage to the engine. The engine does not stall as a result of the fire being extinguished, thus assuring mobility during and after a fire.

The HTL Engine Compartment AFES also has extensive Built-In-Test-Equipment (BITE) and requires no separate test equipment to verify its performance. As with the crew compartment AFES, each time vehicle power is switched on, a complete BITE test sequence is initiated. The control electronics are tested to verify fire signals and can be received and processed. The solenoid drive circuit is tested to verify it can actuate a valve. The thermal wire monitors the pressure in the fire extinguishers, the continuity of the electrical cable and the thermal wire loop for electrical short circuits. Again the crew know if they have an Engine Compartment AFES before they start their mission. If the system has a problem, a fault light and an LED are illuminated isolating the malfunctioning module(s). The system also has a second shot feature to provide protection in the

The second reason the crew and engine systems are discrete subsystems is, if one is damaged, the other is not affected and remains operational.

Lastly, the HTL AFES includes a manual actuator system. This is a mechanical leverage device which allows simultaneous discharge of the engine and crew compartment extinguishers from an external handle. In the event a fire is observed in an unattended vehicle and electrical power is off to the AFES, this handle can be pulled thus extinguishing the fire. Connecting this handle to both subsystems eliminates the need to determine where the fire has started

Key system components

Optical Fire Sensor Assembly (OFSA): This optical detector is a Type 1 Discriminating OFSA meeting MIL-S-62546A. The OFSA employs three optical sensors (two photodiodes and one thermopile) filtered to far infrared (IR), near IR and visible light wavelengths which allow the patented fire detection logic to sense the start of explosive fires quickly while discriminating against false alarm sources and penetration where no explosion and fire follow. The HTL OFSA provides two separate levels of fire warnings, small and large. It has optical BITE which verifies not only its electrical operation but also whether the sensor lenses are clean and can see a fire

Module, Standard Control Electronics (MSCE): This unit, which is qualified to MIL-M-62545A, can monitor up to four OFSAs and discharge automatically up to four fire extinguishers in a 2 x 2 two shot configuration. It has a complete BITE capability which verifies the unit's ability to monitor OFSAs, process fire signals and perform the fire extinguisher's selection logic and the ability of its solenoid drive circuit to actuate the fire extinguisher valves. This unit also provides BITE monitoring and test sequence data and fault isolation data to the operator interface panel. Another model of this unit, which has been qualified on the M992 FAASV to the requirements of ATPD-2082, is also available which can monitor up to four OFSAs and discharge automatically up to six fire extinguishers in 3×2 two shot configuration for larger compartmentalised vehicles.

Crew Compartment Test and Alarm Panel Assembly (CCTAP): This is the crew interface panel for the Crew Compartment AFES. Units are available for two shots, two extinguishers per shot systems and two shots. three extinguishers per shot systems. Both versions have been qualified on the M992 FAASV to the requirements of ATPD-2082. The panel provides indicators for fire, system fault, BITE test sequence pass and power status. Fault isolation indicators are provided for each major module. A BITE test initiate and lamp test switch is provided. A guarded manual discharge switch is included. There is also a screw driver actuated power switch for vehicle maintenance. The unit has a timer which senses the turn off of vehicle power and keeps the system operational for three hours during this critical period.

Valve and Bottle Assembly: The HTL Valve and Bottle Assembly or fire extinguisher has been qualified to MIL-V-62547A. It is available in three capacities. It features a solenoid actuated valve that opens in milliseconds quickly discharging its Halon 1301 fire extinguishing agent which has been super pressurised with dry Nitrogen to speed discharge time.

Thermal Detection Wire: This wire senses increases in heat caused by fires or engine overheating. Two levels of warning are provided. One for small fires or overheat which causes a fire warning indicator to flash on the crew interface panel or an audible warning signal can also be provided. The larger fire warning automatically discharges the Valve and Bottle Assembly extinguishing the fire.

Engine Compartment Test and Alarm Panel (ECTAP): This unit incorporates the features of the crew compartment MSCE and CCTAP into a single unit. The unit monitors the thermal detection loop and actuates the valve solenoid when a large fire occurs. It has the same type of BITE and fault isolations as the Crew Compartment AFES presenting an identical interface to the vehicle crew as that system. It has been qualified on the M992 FAASV to ATPD-2082. A similar version (with the annunciator and control functions remoted to the driver panel) is qualified and in service on all South Korean Type 88 MBTs.

Status: In full production since 1984 for the US Army. Continuing international deliveries. Under trial for many vehicles, both new and retrofits. These include US and foreign military applications.

Manufacturer: Pacific Scientific, HTL/Kin-Tech Division, 1800 Highland Avenue, Duarte, California 91010, USA.

Telephone: (818) 359 9317 Fax: (818) 359 7013

AFV Engines, Transmissions and Powerpacks

BRAZIL

Bernardini M41 Repower Package

Development/Description

The Bernardini Company, prime contractor for the X1, X1A1 and X1A2 light tanks, has modernised some 400 M41 series light tanks for the Brazilian Army and Marine Corps with modernised powerpacks and upgrading of the 76 mm gun to 90 mm.

The original 500 hp petrol engine has been replaced by a Brazilian built Saab-Scania DS-14A 04 eight-cylinder diesel developing 405 hp which is coupled to the standard CD-500-3 automatic transmission.

To install this engine the rear hull has been enlarged and a new cooling system consisting of a radiator and two 12-blade fans has been installed.

Other improvements include the modification of the electrical system with two 12 V batteries and four 60 Ah alternators (eliminating the need for the generator previously fitted), new instrument panel and redesigned fuel tanks

Status: Conversions complete for Brazilian Armed Forces. Now being offered for export. A quantity of these repower packages have also been sold to Uruguay.

Manufacturer: Bernardini S/A Industria e Comercio, Rue Hipolito Soares No 79, 04201 Sao Paulo SP, Brazil.

Telephone: (011) 274 8033 Telex: (011) 21605 bsaibr



Rear view of M41B showing engine and air cooling fans, travel lock for new 90 mm gun and tool boxes over tracks

Moto Pecas M113 Diesel Conversion

Development/Description

The Brazilian Army had about 600 of the original M113 series APCs powered by the Chrysler 75M V-8 petrol engine developing 209 bhp at 4000 rpm. This has a maximum road speed of 64.37 km/h and the 302 litres of fuel gave a maximum cruising range of 321 km.

These have now been converted into the diesel configuration by Moto Pecas which has developed a diesel conversion kit with the assistance of the Centro Technológico do Exército (Army Technological Centre).

The original petrol engine has been replaced by the Mercedes-Benz OM-352-A which has a much lower fuel consumption and gives an operational range of 520 km. This engine is made in Brazil and is lighter than the original so no modifications to the suspension of the M113 are required. The original transmission and transfer box has been upgraded by Moto Pecas and the original electrical system has been reworked to facilitate maintenance. The engine cooling system has been redesigned with the cooling fan now blowing air out of the engine compartment rather than into it.

Status: Produced for the Brazilian Army and being offered for export. As of 1 January 1993 the company had manufactured 586 M113 retrofit kits.

Manufacturer: Moto Pecas, Avenue Hollingsworth 719, CEP 18.100 Sorocaba SP, Brazil.

Telephone: (55) 152 329444 Telex: 152-145 MPTE-BR

Fax: (55) 152 323675



Moto Pecas M113 diesel conversion kit showing main components with engine on right

CHINA, PEOPLE'S REPUBLIC

NORINCO Type 12150L Diesel Engine

Description

The NORINCO 12150L is a water-cooled, 4-cycle, direct injection V-12 diesel engine which is installed in the Type 59 MBT, although it is also suitable for installation in other armoured vehicles, engineer vehicles and marine applications.

Variants

A more powerful version of this is designated the Type 12150L-7BW which develops 580 hp at 2000 rpm. This is known to be installed in the Type 69 MBT, Type 84 AVLB, Type 653 ARV and the Type 80 twin 57 mm SPAAG.

SPECIFICATIONS Model

CONSTRUCTION CONFIGURATION RATED OUTPUT MAX TORQUE SPEED AT MAX

TORQUE SPECIFIC FUEL CONSUMPTION

180 g/hp/h WEIGHT (dry) 895 kg 1583 mm LENGTH WIDTH 896 mm HEIGHT 905 mm

1200 to 1300 rpm 1300 to 1400 rpm

> 175 g/hp/h 930 kg 1583 mm 896 mm 907 mm

121501 - 7RW

60° V-12

alloy and aluminium

580 hp/2000 rpm

 $250 \pm 10 \text{ kg m}$

Status: In production. Installed in Type 59 MBT.

Manufacturer: Chinese state factories. NORINCO, China North Industries Corporation, 7A Yuetan Nanjie, PO Box 2137, Beijing, People's Republic of China

Telephone: (86) 6898. (86) 3461, (86) 3471, (86) 7570

121501

60° V-12

nickel-chromium

520 hp/2000 rpm

 $230 \pm 10 \text{ kg m}$

Telex: 22339 CNIC CN



NORINCO Type 12150L-7BW V-12 diesel which develops 580 hp at 2000 rpm

NORINCO X150-960 Diesel Engine

Description

The NORINCO X150-960 is a turbocharged, intercooled, four-stroke, direct injection, high-speed diesel engine which is suitable for installation in tracked armoured vehicles but can also be used in other applications such as construction equipment or generating sets. At present it is uncertain as to which AFV this engine is fitted into, but it could be the follow-on to the Type 80 MBT.

SPECIFICATIONS

CONFIGURATION CYLINDER DIAMETER CYLINDER STROKE SWEPT VOLUME OUTPUT

MAX TORQUE **FUEL CONSUMPTION** ENGINE OIL

CONSUMPTION WEIGHT LENGTH WIDTH (without charger

and intercooler) HEIGHT

60° V-12 150 mm 160 mm 34.641

960 hp at 2200 rpm 360 kg m at 1500 rpm

175 g/hp/h

4 g/hp/h 1600 kg 1394 mm

940 mm 950 mm

Status: Believed to be in production.



NORINCO X150-960 V-12 diesel engine

Manufacturer: Chinese state factories. NORINCO, China North Industries Corporation, 7A Yuetan Nanjie, PO Box 2137, Beijing, People's Republic of

Telephone: (86) 6898, (86) 3461, (86) 3471, (86) 7570

Telex: 22339 CNIC CN

DENMARK

EFS M41 Diesel Repower Package

Development

The E Falck Schmidt company of Denmark has been involved in the overhaul and repair of armoured fighting vehicles for the Danish armed forces for over 25 years. In addition to overhauling the M41 light tank and M109 155 mm self-propelled howitzer, over 1000 M113 series APCs have been overhauled. E Falck Schmidt was awarded the contract for the prototype installations in the M41 light tanks as well as the contract for the delivery of the diesel repower packages for the Danish M41 fleet. The programme was completed in 1987.

This repower package was developed to meet the requirements of the Danish Army and after extensive trials of competing designs offered to the Danish Army, the E Falck Schmidt repower package was chosen.

Description

The basis for the repower package is the US Cummins VTA 903 TR coupled directly, without an intermediate gearbox, to the original CD-500 transmission. The engine develops 465 hp gross at 2600 rpm.

The repower package comprises the following subsystems. The cooling system consists of two belt-driven fans and two radiators, one set mounted on each side of the powerpack. This system cools both the engine and the crossdrive. The belt enables the engine to run on half the cooling system if one belt and/or fan is damaged in combat.

The cooling air is taken through the top deck grille, along the engine. down over the specially shaped fuel tanks as well as from around the transmission and blown through the air shrouds and out of the vehicle engine compartment through radiators which are protected by a special grille. The cooling fans are protected by an automatic clutch to disengage them when starting and/or stopping the engine.

The two fuel tanks, specially shaped to allow a high airflow to the fans, have a total capacity of 930 litres which gives a road cruising range of about 750 km



Danish M41 DK-1 fitted with EFS repower package, from rear with turret traversed to left rear

222 AFV ENGINES, TRANSMISSIONS AND POWERPACKS / Denmark — France

The 24 V electrical system has six 12 V batteries separated into starting and operating systems, connecting together but ensuring that the engine starting batteries cannot be discharged and cause starting problems.

The air filter unit cleans the air in two stages. The primary with a cyclone filter element and the secondary with four dry filter elements. Air is taken from the engine compartment. The exhaust silencer box and pipe are mounted on the right fender and covered by a heatshield to minimise thermal radiation.

The instrument panel has been redesigned and a small portable instrument panel with a magnetic foot and a master warning light installed in the engine compartment.

The engine compartment topdeck is designed to adapt most of the parts from the original topdeck. Batteries and air filter elements are mounted in armoured boxes on the left rear fender.

The kit also contains a cold starting aid device, mounting facilities for a fire extinguishing system and heater assemblies.

Status: Production complete but can be resumed. In service in Denmark.

Manufacturer: E Falck Schmidt A/S, Tolderlundsvej 106, DK-5000 Odense C. Denmark.

FRANCE

Baudouin 6-cylinder Diesel Engines

Development

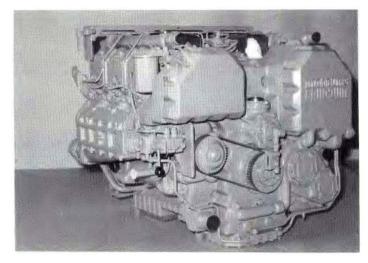
These engines were originally developed for a variety of civilian applications but the 6F 11 SRY has been adapted for repowering the AMX-13 light tank while the 6F 11 SRX has been installed in the AMX-10P (Marine) and AMX-10 PAC 90 90 mm fire support vehicles delivered to the Indonesian Marines. In 1983 it was announced that the 6F 11 SRX was also to be installed in all future production AMX-10RC (6 \times 6) reconnaissance vehicles of the French Army and to be retrofitted to earlier production vehicles (powered by the Hispano-Suiza HS 115-2 diesel) in due course. This engine is said to offer an increase in horsepower, 20 per cent saving in fuel consumption and a reduction in exhaust gases when compared to the current engine.

More recently the 6F 11 SRX engine has been installed in the AMX-10RC vehicles supplied to Qatar and in the AMX-10 PAC 90 Fire Support Vehicles and 22 AMX-10P Marine with 25 mm turrets for Singapore. The 6F 12 SRY 400 turbocharged diesel developing 400 hp is fitted to the prototypes of the private venture MARS 15 family of light armoured vehicles.

Description

The engines feature individual cast iron cylinder heads, cast iron crankcase with wet cylinder liners, oil-cooled pistons, built-in lubrication system, built-in water circuit, two possible starting devices (electric or hydraulic) and heat dissipation by water circuit. Other developments with the 6F 11 ST (204 hp at 3400 rpm) is used to power the Crotale anti-aircraft system from Thomson-CSF.

Other diesel engines manufactured by the company include the 12F 120



Baudouin 6F 11 SRY, used to repower AMX-13 light tanks

SR (developed from the F 11 series) developing $840/900 \, hp$ at $3000/3200 \, rpm$, $12F \, 11 \, SR$ (maximum output of $500 \, hp$ at $3000 \, rpm$), $12F \, 11 \, S$ (maximum output of $400 \, hp$ at $3000 \, rpm$), $6F \, 11 \, S$ (maximum output of $240 \, hp$ at $3000 \, rpm$) and $6F \, 11 \, SR$ (maximum output of $306 \, hp$ at $3000 \, rpm$).

SPECIFICATION	IS					
Model	Cylinders	Bore/stroke	Swept volume	Output/rpm	Max torque	Application
6F 11 SR	6 V	115 × 105 mm	6540 cm ³	225 kW/3000	840 Nm	base engine design
6F 11 TV	6 V	115 × 105 mm	6540 cm ³	125 kW/3000	525 Nm	VXB repower
6F 11 ST	6 V	115 × 105 mm	6540 cm ³	150 kW/3400	560 Nm	Crotale
6F 11 SRY	6 V	115 × 105 mm	6540 cm ³	206 kW/3200	760 Nm	AMX-13
6F 11 SRX	6 V	115 × 105 mm	6540 cm ³	206 kW/3000	780 Nm	AMX-10
6F 12 SR	6 V	120 × 105 mm	7120 cm ³	294 kW/3000	1125 Nm	base engine design
6F 12 SRY	6 V	120 × 105 mm	7120 cm ³	294 kW/2900	1140 Nm	MARS 15
6F 12 SRX	6 V	120 × 105 mm	7120 cm ³	294 kW/3000	1125 Nm	
8F 120 SR	8 V	120 × 110 mm	9950 cm ³	442 kW/3000	1700 Nm	under development
12F 120 SR	12 V	120 × 110 mm	14 930 cm ³	784 kW/3000	2400 Nm	base engine design
12F 120 SR	12 V	$120 \times 110 \text{ mm}$	14 930 cm ³	537 kW/2700	2260 Nm	EFA



Status: $50 \times 6F$ 11 SRX for AMX-10P (Marine) supplied to Indonesia and Singapore, $428 \times 6F$ 11 SRX for repowering the AMX-10RC French Army, and Qatar, $5 \times 6F$ 11 SRY installed in AMX-13 for trials, in co-operation with French Army, and CLI and 6F 11 TV for repowering the VXB of French Gendarmerie. 12F 120 SR is also installed in the prototype of the EFA amphibious crossing vehicle designed by CEFA and approved by the French Army after a 500 hour test at the ETAS. After extensive trials the 12F 120 SR was adopted for series production vehicles for the French Army.



Manufacturer: Moteurs Baudouin, 165 boulevard de Pont-de-Vivaux, BP32,

F-13362 Marseilles Cedex 10, France. Telephone: (1) 91 83 85 00 Telex: 410944 F

Fax: (1) 91 79 09 38

Baudouin 6F 11 ST engine for Thomson-CSF Crotale SAM system

Panhard AML Upgrade Kit

Development/Description

Panhard has developed an upgrade package for the widely deployed AML (4 × 4) armoured car used by many countries around the world.

The modernisation package covers three main areas: replacement of the existing petrol engine by a more fuel efficient diesel engine, replacement of infra-red night vision equipment by image intensification equipment and modification of the Giat Industries 90 mm gun to fire APFSDS ammunition.

The standard Panhard AML is powered by the Panhard Model 4HD petrol engine developing 85 hp at 4700 rpm which gives the vehicle a maximum range of 600 km. The 4HD engine was developed some 30 years ago and has now gone out of production. In addition to providing 15 per cent more power, the new diesel engine gives a substantial 50 per cent increase in torque

The Panhard retrofit package utilises the Peugeot XD 3T turbocharged air-cooled diesel engine developing 95 hp. This has been installed in late production AML armoured cars and is also installed in the more recent Panhard VBL (4 × 4) light armoured vehicle in service with the French Army. It was originally developed for the civil market so spare parts are obtainable from a wide range of sources.

Extensive trials in the Middle East and Far East have shown that the new engine will operate in temperatures as high as +50°C.

As shown in the comparative table, when fitted with the new engine. acceleration and maximum speed of the AML is increased and, as spare parts are easily available, life cycle costs should be reduced. In addition there is a much reduced risk of fire with a diesel engine than a petrol engine.

The modifications include a new rear hull, alternator, engine, mechanical control clutch, reinforced gearbox, hydraulic control cooling system and a new exhaust system. The rear suspension of the AML is reinforced to take into account the increased weight of the new engine.



Modifications are also carried out to the fuel circuit, driver's dashboard. main electrical control box and rear mudguards.

As an option, a more powerful Peugeot air compressor can be installed and a new Citroen brake system fitted, with the front brakes being of the disc type.

The Giat Industries 90 mm F1 gun currently fires canister, HE, HEAT and smoke projectiles. The HEAT round, however, has limited effectiveness against certain targets so Giat Industries is developing an APFSDS round that can be fired from a modified Giat 90 mm F1 gun.

This new round has a muzzle velocity of 1050 m/s and will penetrate 50 mm of armour at zero degrees incidence at a combat range of 1300 m. In order to fire the new APFSDS round the muzzle brake and recoil system have to be modified. The ammunition load of the AML remains 20 rounds even when carrying APFSDS ammunition.

The existing infra-red night vision equipment for the commander, gunner and driver has obvious battlefield limitations so in this modernisation package it is replaced by SOPELEM image intensification equipment. In addition, the gunner is also provided with a laser rangefinder mounted externally over the gun mantlet to improve its first round hit probability.

Panhard also offers the Peugeot/Renault/Volvo V-6 water-cooled petrol engine developing 145 hp at 5000 rpm as a replacement for the Panhard petrol engine and this gives an even greater power-to-weight ratio and acceleration.

In addition Panhard offers armament upgrades for the AML-60 and the re-engined package for the AML is also suitable for the Panhard M3 (4×4) APC which is also used by many countries.

Panhard can either modify the vehicles in France or supply kits to enable the user to convert the vehicles in his own facilities. Another alternative is that Panhard upgrades the first vehicles in France with the user's personnel being trained at the same time to undertake the conversion of the remaining vehicles in their own facilities.

SPECIFICATIONS

	New AML	Old AML
Engine type	XD 3T	4 HD
OUTPUT	95 hp	85 hp
TORQUE	20.8 m.daN	15 m.daN
COOLING	liquid	air
WEIGHT (AML 90)	5.9 t	5.5 t
WEIGHT (AML 60)	5.2 t	4.8 t
MAX ROAD SPEED	95 km/h	90 km/h
ACCELERATION	66 s/1000 m	69 s/1000 m
RANGE ON ROAD	900 km	650 km
FORDING	1.1 m	0.9 m

Status: Development complete. In production. In service with undisclosed countries

Manufacturer: Société de Constructions Panhard et Levassor, 18 avenue d'Ivry, F-75621 Paris, France. Telephone: (1) 40 77 40 00 Telex: 270 276

Upgraded Panhard AML 90 (4 x 4) armoured car

224 AFV ENGINES, TRANSMISSIONS AND POWERPACKS / France

SACM Diesel UDX Range of Military Engines

Development/Description

Based on a common architecture, the engines of the UDX series have been developed by SACM to meet the requirements of present and future generations of battle tanks and other heavy vehicles. According to SACM their design and integration capacity enables very compact powerpacks to be achieved. Among the advanced technologies incorporated into the design of this range of engines are:

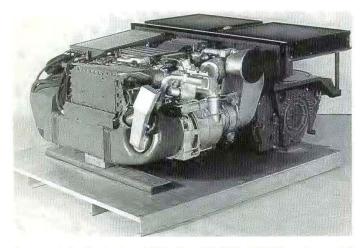
- (a) supercharging devices that double the power with reference to conventional engines whilst maintaining the same reliability level
- (b) electronics which monitor and control the engine
- (c) selection of aeronautic quality solutions and materials.

The simplicity of construction and operating economy found in conventional engines are maintained and the SACM Diesel UDX engine range shows the possibility of using the same basic engine type to power all of the armoured vehicles employed by an army.

SPECIFICATIONS

Type	Output	at 2500	Number of cylinders	Maximum torque Nm	Total swept volume in
	kW	hp		F3000M • F900 D00 3000	litres
UD V6X 550 T5*	400	550	6	1680	12.35
UD V6X 650 T6*	475	650	6	2100	12.35
UD V8X 730 T5	535	730	8	2240	16.47
UD V8X 880 T6	645	880	8	2850	16.47
UD V12X 1100 T5	810	1100	12	3370	24.70
UD V12X 1300 T6	955	1300	12	4270	24.70
UD V8X 1500 T9	1100	1500	8	4580	16.47
UD V8X 730 T5 UD V8X 880 T6 UD V12X 1100 T5 UD V12X 1300 T6	535 645 810 955	730 880 1100 1300	8 8 12 12	2240 2850 3370 4270	16.47 16.47 24.70 24.70

^{*}Under development



Powerpack for the Leclerc MBT with a UD V8X 1500 T9 engine on left, transmission lower right and radiators top right

INFORMATION COMMON TO THESE:

BORE 142 mm
STROKE 130 mm
UNIT SWEPT VOLUME 2.05 I
DIRECT INJECTION 2 VALVES PER CYLINDER
PISTONS COOLED BY OIL CIRCULATION
MEAN PISTON SPEED 10.8 m/s
WET TYPE LINERS
WATER COOLING SYSTEM

Status: UD V8X 1500 T9 engine is installed in the Giat Industries Leclerc MBT which is now in production for the French Army while the UD V12X 1300 T6 engine is installed in prototypes of the Giat Industries AMX-40 MBT. The latter has been designed for the export market but has yet to enter production.

Manufacturer: SACM Diesel. Head Office, 1 rue de la Fonderie, BP 1210, F-68054 Mulhouse Cedex, France. Military Division, 124 boulevard de Verdun Bruyères, F-92400 Courbevoie, France.

Telephone: (1) 47 68 54 48 Telex: 611 156F Fax: (1) 47 68 51 14



SACM V8X 880 T6 diesel engine

Renault Engines

Development/Description

Renault Véhicules Industriels produces a wide range of engines consisting of two basic families. First are the specific military engines which comprise the HS 110, HS 115 and HS 115 ID. Second are military engines derived from the civilian models developed by the group over an unbroken range of power outputs from 250 to 1000 hp, MIDR 06-02-26, MIDR 06-20-45 and the E9.

HS 110 Diesel

This was manufactured under licence from Hispano-Suiza and has also been built in Spain for the Spanish-built AMX-30 MBTs. The current production model, designated the HS 110-2, has an output of 500 kW (680 bhp) at 2400 rpm but a more recent model, the HS 110-2S, with turbocharging and charge-air cooling, has an output of 552 kW (750 bhp). The HS 110 engine, which can run on petrol or diesel, was manufactured under licence from Hispano-Suiza but the licence, technology, development and drawing office have been purchased by Renault Véhicules Industriels. By January 1993 a total of 5033 HS 110 series diesel engines had been completed.

SPECIFICATIONS

CONFIGURATION

CONSTRUCTION CYLINDER DETAILS bore stroke liners

FUEL SYSTEM ASPIRATION SWEPT VOLUME COMPRESSION RATIO

COOLING RATING max power max torque LENGTH WIDTH HEIGHT

WEIGHT

APPLICATIONS

12-cylinder horizontally opposed compression ignition light alloy

145 mm 145 mm

wet

12-cylinder in-line injection pump 2 Holset turbo compressors 28.73 l

28.73 21:1 water

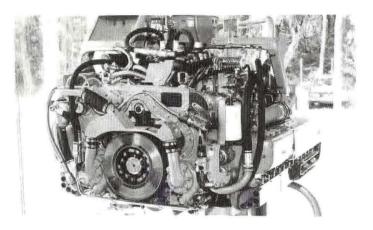
500 kW at 2400 rpm 2079 Nm at 1600 rpm 1.553 m

1.25 m 0.84 m

1426 kg (1726 kg for AMX-30

application)

all members of AMX-30 MBT family



Renault-built HS 110 12-cylinder diesel for AMX-30 tank family

E 9 Diesel Engine in 700, 750, 900 and 1000 hp versions

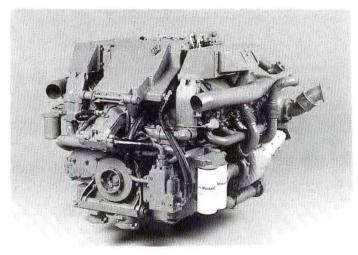
This engine is derived from the Mack V8 500 hp civilian US truck application. The military version has been developed in conjunction with Mack of the US and the first announcement of the engine was made by Renault in 1987. Features of the engine can be summarised as follows: it operates on 60 per cent gradients and 30 per cent side slopes, has a dry crankcase for specific applications, power take-off for driving high power auxiliaries and the ability to start at very low temperatures. The E9 is being offered for various military applications including engine ratings to 700 hp for tank transporters and engine ratings of 750 to 1000 hp for armoured vehicles either as original equipment or for powertrain retrofit.

The E9 engine rated at 750 hp is now being offered as a repower package for the Giat Industries AMX-30 family of MBTs. According to the manufacturer, the Renault E9 turbocharged intercooled engine can be integrated into the AMX-30B2 MBT (hydrostatic) without any modification. For trials purposes an E9 engine coupled to a General Electric HMPT-1000 series fully automatic transmission has been installed in a M103 heavy tank chassis with a weight of 45 tons (US).

SPECIFICATIONS CONFIGURATION 8-cylinders at 90° 4-stroke, direct injection, 4 valves per cylinder CONSTRUCTION cast iron engine block and cylinder heads CYLINDER DETAILS 136.5 mm bore 139.7 mm stroke SWEPT VOLUME

16.41

Version	700 hp	750 hp	900 hp	1000 hp
Cooling System	air/air	air/water	air/water	air/water
Max output kW	515	552	662	736
hp	700	750	900	1000
Max torque mdaN	230	240	290	310
at rpm	1800	1800	1900	1900
ENGINE DRY WEIGH	4T	1250 kg		



E9 engine in 750 hp version used to repower AMX-30 MBT



Renault-built HS 115-2 8-cylinder diesel

HS 115-2 Diesel

This was manufactured under licence from Hispano-Suiza and in 1983 Renault tested direct injection, turbocharging and intercooling that enabled the output of the HS 115 to be raised to 269 kW (360 hp).

The licence to produce this engine, together with its technology, development and drawing office, has now been purchased by Renault Véhicules Industriels. Production of the HS 115 series engine for the AMX-10P series and other armoured vehicles has now reached over 2500 units.

SPECIFICATIONS

90° V-8 CONFIGURATION CONSTRUCTION light alloy CYLINDER DETAILS 110 mm bore stroke 108 mm liners wet SUPERCHARGING 1 turbocharger SWEPT VOLUME 8.211 COOLING water RATING 194 kW at 3000 rpm max power 659 Nm at 2200 rpm max torque LENGTH 1.11 m WIDTH 0.76 m HEIGHT 0.97 m 625 kg WEIGHT APPLICATIONS

all members of AMX-10P family of tracked vehicles, AMX-10RC (6 × 6) reconnaissance vehicle and former Yugoslav M80 MICV (Note that last production models of AMX-10RC 6×6 vehicles had the Baudouin 6F 11 SRX in place of the HS 115-2 diesel)

HS 115 ID Diesel Engine

This is a further development of the previous engine and features a power take off for driving high power auxiliaries, the ability to start at very low temperatures and to operate on 60 per cent gradients and 30 per cent side slopes

SPECIFICATIONS CONFIGURATION

CONSTRUCTION CYLINDER DETAILS

bore stroke COMPRESSION RATIO SWEPT VOLUME TURBOCHARGING AIR COOLING SYSTEM MAX OUTPUT

MAX TORQUE OIL CAPACITY WATER CAPACITY (engine only) ENGINE DRY WEIGHT 8-cylinders at 90°. 4-stroke direct injection light alloy engine block and cylinder-head

100 mm 108 mm 16.5:1 8.21

air/water type 269 kW (360 hp) at 3000 rpm 81 mdaN at 2000 rpm 421

211

650 kg

MIDR 06-02-26 Engine

Produced since 1989, the MIDR 06-02-26 engine incorporates the advanced technology of the RVI group engines and the latest innovations arising from the research carried out on combustion. Two versions are available: Version 1 develops 166 kW (226 hp) at 2350 rpm while the other develops 184 kW (250 hp) at 2500 rpm.

SPECIFICATIONS

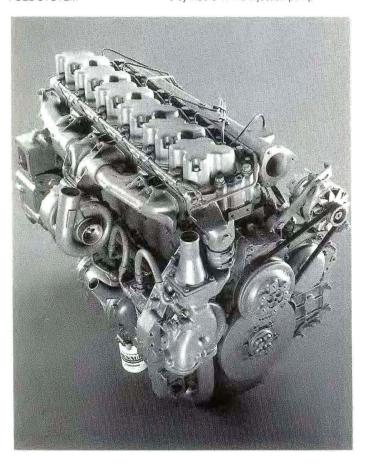
CONFIGURATION CYLINDER DETAILS: 6-cylinders vertical in-line

bore

102 mm

stroke FUEL SYSTEM 126 mm

6-cylinders in-line injection pump



ASPIRATION 2 Garrett turbo compressors AIR COOLING SYSTEM air/air type SWEPT VOLUME 6.18 dm³ COMPRESSION RATIO 17.5:1 MAX OUTPUT 184 kW (250 hp) at 2500 rpm MAX TORQUE 90 mdaN at 1500 rpm LENGTH 1.139 m WIDTH 720 mm 819 mm HEIGHT

MIDR 06-20-45 Engine

WEIGHT (engine dry)

APPLICATIONS

VERSION

The MIDR 06-20-45, a variant of the MIDS 06-20-45 engine already fitted on the VAB and TRM 10 000 vehicles, offers a higher specific level of power due to the use of a turbocharger with an intercooler. By early 1993 a total of 1500 of the MIDR 06-20-45 engine had been produced. There are four members of this family, each with different power outputs:

530 kg

VAB and other armoured vehicles

TORQUE

	0.0.1		
VER:	SION MIDS	194 kW (265 hp) at 2200 rp	m 100 m.daN at 1400 rpm
VER:	SION 1 - MIDR	240 kW (326 hp) at 2000 rp	m 137 m.daN at 1400 rpm
VER	SION 2 - MIDR	295 kW (400 hp) at 2500 rp	m 150 m.daN at 1860 rpm
VER:	SION 3 - MIDR	331 kW (450 hp) at 2500 rp	m 160 m.daN at 1800 rpm
SPE	CIFICATIONS		
CON	FIGURATION	6-cylinders ve	rtical in-line
CYLI	NDER DETAILS		

120 mm bore stroke 145 mm FUEL SYSTEM

POWER

6-cylinders injection pump ASPIRATION 1 turbo compressor AIR COOLING SYSTEM air/air type or air/water type

SWEPT VOLUME 9.84 dm3 COMPRESSION RATIO 16:1 MAX OUTPUT

air/water 295 kW (400 hp) at 2500 rpm air/air 331 kW (450 hp) at 2500 rpm

LENGTH 1.245 m WIDTH 767 mm HEIGHT 1.001 m WEIGHT 880 kg

Manufacturer: Renault Véhicules Industriels, Defence Direction, 40 rue Pasteur, F-92156 Suresnes Cedex, France. Telephone: 40 99 71 11 Telex 620 567 F SDCE+

Renault MIDR 06-20-45 diesel engine

Renault Transfluide Transmission

Development/Description

This transmission is installed in the VAB (4 \times 4 and 6 \times 6) range of armoured personnel carriers and the VBC 90 (6 \times 6) armoured car, and it is suitable for installation in vehicles powered by engines rated at between 200 and 300 hp. It consists of a hydrokinetic torque converter and a gearbox with five forward and one reverse gears. The torque converter ratio can be 1.85 to 2.4:1 depending on the application. Gear changing is assisted by a pneumatic drive and a lock up system is available as an optional extra, as is a power take off.

SPECIFICATIONS

LENGTH 870 mm WIDTH 500 mm HEIGHT 520 mm WEIGHT 280 kg

MAX TORQUE 80 kgm (at converter input) SPEED 3000 rpm (max converter input)

Status: Production. In service with the French Army and many other countries

Manufacturer: Renault Véhicles Industriels, Defence Direction, 40 rue Pasteur, F-92156 Suresnes Cedex, France.

Telephone (1) 40 99 71 11 Telex 620 567 F SDCE+

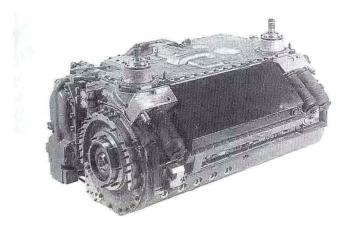
SESM Transmissions

Development

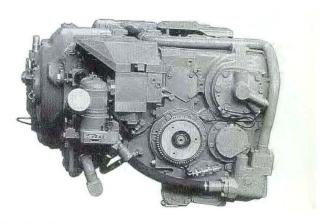
This company has developed a complete range of transmissions for engines with an output of 200 kW to 1200 kW. Main advantages can be summarised as fully automatic or manual control, power shift, hydrostatic steering ensuring good turn radius with positive control and, in the no-steer mode, stability without having to compensate steering in any terrain configuration, on-the-spot pivoting even on a slope, possibility of changing gear on curves and engaging reverse gear while still travelling forwards. The ESM 500 transmission is for the new French Army MBT, the Leclerc, and was installed in the fourth prototype of the AMX-40 shown in June 1985. The ENC 200 is installed in the AMX-32 MBT. The AMX-32 and AMX-40 were both private venture vehicles for export and are no longer being marketed by Giat Industries. The ESM 500 transmission is now in production for the French Army's Leclerc MBT, first production examples of which were completed by Giat Industries late in 1991.

Manufacturer: SESM (Société d'Equipements Systèmes et Mécanismes), Clos des Borgnes, Z.I.d'Epluches, F-95310 Saint-Ouen-l'Aumone, France. Telephone: (1) 34 64 41 55 Telex: 609 467 F

SPECIFICATIONS ESM 100 ENGINE POWER ENGINE SPEED	200 kW 2600 rpm	300 kW 3200 rpm	WEIGHT OF TRANSMISSION GEARS 1st gear forwards	1600 kg 4.04:1		LENGTH WIDTH HEIGHT	961 mm 1475 mm 740 mm	
VEHICLE WEIGHT	13 t	18 t	2nd gear forwards	2.33:1		ESM 500		
WEIGHT OF			3rd gear forwards	1.49:1		ENGINE POWER	750 kW	1200 kW
TRANSMISSION	450 kg	450 kg	4th gear forwards	0.93:1		ENGINE SPEED	2200 rpm	2600 rpm
GEARS			5th gear forwards	0.62:1		VEHICLE WEIGHT	50 t	60 t
1st gear ratio	5.36:	1	LENGTH	961 mm		WEIGHT OF		
2nd gear ratio	3.40:	:1	WIDTH	1475 mm		TRANSMISSION	1900	kg
3rd gear ratio	1.88:	:1	HEIGHT	740 mm		GEARS		
4th gear ratio	1.19:	:1				1st gear ratio	5.36:1	
1st reverse	6.42:	:1	ENC 250			2nd gear ratio	3.4:1	
2nd reverse	2.26:	:1	ENGINE POWER	550 kW	650 kW	3rd gear ratio	1.88:1	
LENGTH (ESM 101)	695 1		ENGINE SPEED	2200 rpm	2500 rpm	4th gear ratio	1.19:1	
WIDTH (ESM 101)	875 1	mm	VEHICLE WEIGHT	45 t		1st gear reverse	6.42:1	
HEIGHT (ESM 101)	630	mm	WEIGHT OF			2nd gear reverse	6.42:1	
			TRANSMISSION	1600 kg		LENGTH	1030 m	m
			GEARS			WIDTH	1526 m	m
ENC 200			1st gear ratio	2.83:1		HEIGHT	670 m	m
ENGINE POWER	450 kW	550 kW	2nd gear ratio	1.49:1				
ENGINE SPEED	2200 rpm	2500 rpm	3rd gear ratio	0.93:1				
VEHICLE WEIGHT	40 t		4th gear ratio	0.62:1				







SESM ENC 200 automatic transmission

GERMANY

FFG M41 Repower Package

Development

Flensburger Fahrzeugbau-Gesellschaft (FFG) has been engaged in the overhaul and repair of armoured fighting vehicles for the German armed forces for some 30 years. Armoured fighting vehicles that have been overhauled include the Leopard 1, M48, M41, M42, Marder 1, most members of the M113 family and Hotchkiss APCs. FFG was also awarded the contract for the installation of the American Garrett GT601 gas turbine developing 580 hp in a German M48 tank, coupled to the original CD-850-5 transmission. This programme was successfully completed late in 1983.

Description

The repower package for the M41 was originally developed to meet Danish Army requirements but in 1985 it chose another powerpack. After looking at a number of diesel engines to replace the existing petrol engine, FFG chose the British Rolls-Royce Motors (now Perkins Engines (Shrewsbury)), Military Engine Division, V-8 Condor which powers the Warrior ordered by the British Army in 1984. In the Warrior application the Condor develops 550 bhp at 2300 rpm but in the FFG M41 application it develops 475 hp (gross) or 400 hp (net).

The engine is similar to that installed in Warrior except that the engine torque arm has been repositioned. A PTO designed by FFG is fitted to the right side of the engine driven off the crankshaft pinion and powers a Volvo hydraulic pump and a Leopard 1 generator.

An FFG designed water input pump cover is installed in place of the standard Perkins one to clear the existing bulkhead. Serck engine and transmission coolers are installed on the left side of the engine and a new single rail exhaust manifold fitted to each bank of four cylinders.

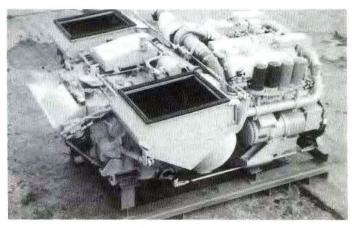
The complete powerpack can be removed in less than 30 minutes. The cooling system has been designed by FFG with one AKG single-finned tube radiator either side to the rear of the engine in the horizontal position with KHD high performance fans underneath. These draw in air from the outside through the existing unaltered armoured louvres on the top of the engine compartment. The air is then pushed through the radiators and out through armoured louvres at the rear. With the FFG conversion there is no cutting of the hull and no need for raised or new rear decking.

The original CD-500-3 transmission has been retained but due to the different rpm of the two engines a reduction gear has been installed between the Perkins Condor V-8 and the existing transmission. A new driver's instrument panel has been designed and the fuel tanks now contain 620 litres of fuel compared to the 530 of the original.

Optional equipment includes a fire detection and suppression system and the British Air-Log Limited, hydrostrut suspension system.

Status: Development completed. Tested in Denmark.

Manufacturer: Flensburger Fahrzeugbau-Gesellschaft mbH, Postfach 1564, D-2390 Flensburg, Federal Republic of Germany. Telephone: (0461) 4812-0 Telex: 22 858



FFG powerpack prior to installation in M41 light tank with radiators on left and

FFG M113 APC Modernisation

Development/Description

In addition to developing a repower package for the M41 light tank, fully described in the earlier entry, FFG, which has been a company within the Diehl Group since late 1986, has started trials of an upgraded M113 series armoured personnel carrier.

This repower package consists of a MAN V-8 Type D2848E diesel engine with a new type of four-jet fuel injection technology developing 206 kW coupled to a ZF LSG 1000 fully automatic transmission (qv) with a maximum torque capacity of 1290 Nm.

The new powerpack was mounted without alteration to the internal bulkheads or the engine compartment opening on four self-adjusting mounting points in the engine compartment.

Steering is accomplished via the automatic ZF LSG 1000 automatic transmission/steering system.

The existing M113 series cooling system was changed to the more recent M113A2 configuration (suction cooling) but modified by a thermostatically controlled hydraulic ventilator drive system.

The upgraded vehicle has an hydraulic dual circuit servo-assisted braking system laid out according to EC guideline 71/320 with separate parking brake system which can hold the vehicle on a 60° slope. The braking system is completely separate and independent of the engine.

Combustion air is drawn in through an external inlet via two air filters with exhaust gas being expelled via insulated pipes and compensators and through the original M113 silencer.

The redesigned driver's position contributes to improved vehicle handling and safety as the driver now has a steering handle rather than the more conventional tillers, parking brake lever and an electric gear lever. The accelerator pedal and the driver's seat are unchanged from the original M113. The instrument display has been redesigned and adapted to the new engine.

The pipework for the fire detection and extinguishing equipment in the engine compartment has been adapted to meet the requirements of the suction cooling system.

Overall, the M113 with the new powerpack has improvements in engine performance, acceleration, steering behaviour, braking system, cross country capability and vehicle handling.

Trials with a vehicle with an all up weight of 15 tonnes resulted in the following figures:

 MAX SPEED
 70 km/h

 ACCELERATION 0 to 50 km/h
 20.3 s

 PIVOT TURN
 8.4 s

 BRAKE ACCELERATION
 5.8 m/s/s

 FUEL CONSUMPTION
 81 l per 100 km (on road at 60 km/h)

Status: Development complete. Vehicle being trialled at the German Army Test Area BW WTD41 in Trier.

Manufacturer: Flensburger Fahrzeugbau-Gesellschaft mbH, Postfach 1564, D-2390 Flensburg, Federal Republic of Germany.

Telephone: (0461) 4812-0 Telex: 22 858 Fax: (0461) 4812-100



New FFG diesel powerpack ready for installation in M113

MTU Motoren- und Turbinen-Union Friedrichshafen GmbH

MTU Friedrichshafen develops, builds, sells and supports power systems equipped with diesel engines, gas turbines, power transmissions and electronic controls for marine, rail or stationary applications and heavy vehicles. The decision to build the Standardpanzer, which became the

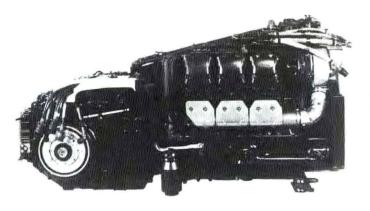
Leopard 1, led to MTU beginning the design of a modular range of AFV engines based on a 3.74-l cylinder. This led to a series 837 engine available in three models, the 6-cylinder MB 833, the 8-cylinder MB 837 and the 10-cylinder MB 838 which powers the Leopard 1 MBT.

SPECIFICATIONS				
MB 837 Series				
Model	MB 833 Aa-501	MB 833 Ea-500	MB 833 Ka-500	MB 833 Ka-501
TYPE	indirect injection,	indirect injection,	indirect injection,	indirect injection,
	4-stroke,	4-stroke,	4-stroke,	4-stroke,
	wet liners	wet liners	wet liners	wet liners
CONFIGURATION	90° V-6	90° V-6	90° V-6	90° V-6
CONSTRUCTION	light alloy	light alloy	light alloy	light alloy
	castings	castings	castings	castings
CYLINDER DETAILS			_	
bore	170 mm	165 mm	165 mm	170 mm
stroke	175 mm	175 mm	175 mm	175 mm
valves	4 per cylinder, with single car	mshaft per bank of cylinders		
DISPLACEMENT	23.8	22.41	22.4	23.8
COMPRESSION RATIO	18:1	19.5:1	18:1	18:1
ASPIRATION	natural	2 turbochargers	2 turbochargers and	2 turbochargers and
			charge air cooler	charge air cooler
RATING				
max power	330 kW at 2300 rpm	440 kW at 2200 rpm	530 kW at 2400 rpm	625 kW at 2400 rpm
max torque	1540 Nm at 1500 rpm	2020 Nm at 1600 rpm	2300 Nm at 1900 rpm	2780 Nm at 1900 rpm
LENGTH	1.252 m	1.255 m	1.252 m	1.252 m
WIDTH	1.05 m	1.257 m	1.05 m	1.05 m
HEIGHT	0.965 m	1.053 m	0.965 m	0.965 m
WEIGHT (dry)	1375 kg	1250 kg	1450 kg	1450 kg
APPLICATION	Repower M41, M44, M52	Marder 1 (ICV), Roland	TAM, VCTP	repower AMX-30

Model TYPE
CONFIGURATION CONSTRUCTION CYLINDER DETAILS bore stroke valves DISPLACEMENT COMPRESSION RATIO ASPIRATION air cooler RATING max power max torque LENGTH WIDTH HEIGHT WEIGHT APPLICATIONS

MB 837 Ba-500 indirect injection, 4-stroke, wet liners 90° V-8 mainly light alloy castings
, , , , , ,
165 mm
175 mm
ishaft per cylinder bank
29.4
19.5:1
1 mechanical supercharg
485 kW at 2200 rpm
2206 Nm at 1750 rpm
1.34 m
1.05 m
1.096 m
1550 kg
Pz 61 and Pz 68 MBT

gs	MB 837 Ea-500 indirect injection, 4-stroke, wet liners 90° V-8 mainly light alloy castings	MB 837 Ka-501 indirect injection, 4-stroke, wet liners 90° V-8 mainly light alloy castings
	165 mm 175 mm	170 mm 175 mm
rger	29.4 l 19.5:1 2 turbochargers	31.8 I 18:1 2 turbochargers and charge
	550 kW at 2200 rpm 2600 Nm at 1600 rpm 1.382 m 1.05 m 0.694 m 1580 kg SLT 50-2 Heavy Equipment Transporter (525 kW/2100 rpm) M47/M48, retrofit (550 kW/2300 rpm), Palmaria	



Jaguar

MTU MB 833 Ea-500 engine coupled to Renk HSWL 194 transmission as MTU engine MB Ca M-500 powering the Leopard 1 MBT



installed in Marder 1	ICV	
Model	MB 838 Ca M-500	MB 838 Ka-501
TYPE	indirect injection,	indirect injection,
	4-stroke,	4-stroke,
	wet liners	wet liners
CONFIGURATION	90° V-10	90° V-10
CONSTRUCTION	mainly light alloy	mainly light alloy
	castings	castings
CYLINDER DETAILS		
bore	165 mm	170 mm
stroke	175 mm	175 mm
valves	4 per cylinder, with single	e camshaft per cylinder bank
DISPLACEMENT	37.41	39.7

Model	MB 838 Ca M-500	MB 838 Ka-501
COMPRESSION	10.51	10.1
RATIO	19.5:1	18:1
ASPIRATION	2 mechanical	2 turbochargers and
	supercharges per bank	charge air cooler
RATING	-	
max power	610 kW at 2200 rpm	1030 kW at 2400 rpm
max torque	2805 Nm at 1550 rpm	4600 Nm at 1600 rpm
LENGTH	1.552 m	1.450 m
WIDTH	1.049 m	1.850 m
HEIGHT	0.964 m	1.040 m
WEIGHT (dry)	1920 kg	2000 kg
APPLICATION	Leopard 1 MBT series vehicles OF-40 MBT	Arjun MBT

Series 870

Originally designed for the US/German MBT-70 programme, the 12-cylinder MB 873 of this engine family was chosen for the Leopard 2 tank after the MBT-70 programme was cancelled. By increasing bore and stroke to 170 and 175 mm respectively, the excellent torque characteristic was further improved giving the Leopard 2 excellent mobility.

The 8-cylinder, originally selected for the trilateral 155 mm SP-70 howitzer, now powers the South Korean K-1 family of armoured vehicles (MBT, ARV and AVLB) as well as prototypes of the Giat AMX-40 MBT and the German Keiler mineclearing vehicle.



SPECIFICATIONS

Model MB 873 Ka-501 TYPE indirect injection, 4-stroke, wet liners CONFIGURATION

47.61

18:1

mainly light alloy castings

CONSTRUCTION

CYLINDER DETAILS bore

170 mm stroke 175 mm valves 4 per cylinder, with single camshaft per bank

DISPLACEMENT COMPRESSION RATIO

ASPIRATION

RATING max power max torque LENGTH

WIDTH HEIGHT WEIGHT (dry) APPLICATION

2 turbochargers; intercooled by charge air cooler in engine coolant system 1100 kW at 2600 rpm

4600 Nm at 1700 rpm 1.7 m 1.97 m 1.1 m 2590 kg Leopard 2 Buffel ARV

MB 871 Ka-501

indirect injection, 4-stroke, wet liners

mainly light alloy castings

170 mm 175 mm

4 per cylinder, with single camshaft per bank

31.71 18:1

2 turbochargers; intercooled by charge air cooler

in engine coolant system

880 kW at 2600 rpm 3720 Nm at 1800 rpm

1.19 m 1.95 m 0.88 m 1700 kg

Type 88 (K-1) MBT, ARV and AVLB, Keiler mine-

clearing tank

Series 880

Since the mid-1970s, MTU has been working on the third generation of tank engines, the series 880. With these engines the installation volume of a powerpack has again been considerably reduced. For example, a powerpack with the 12-cylinder engine MT 883 has the same power rating as the Leopard 2 engine but requires only 60 per cent of its installation volume

Major design features of the MTU 880 series are direct injection, four valves per cylinder, digital engine electronic management and variable turbocharger and intercooler arrangement for specific needs. Modern turbocharger technology allows a high torque rise of 30 per cent in the important speed range.

Prototype powerpacks have been built by MTU for several vehicles in the United States and Europe including the German PzH 2000 155 mm selfpropelled artillery system, the German Marder 2 armoured infantry fighting vehicle (which was cancelled late in 1992), the US programme for the Advanced Amphibious Assault Vehicle and for the French Giat Industries Leclerc MBT.

MTU has been awarded a contract for an undisclosed number of Euro Powerpacks from Giat Industries of France and the first of these was shipped late in 1992. The Euro Powerpack incorporates the MTU MT 883 V-12 diesel, a transversely mounted Renk HSWL 295 TM automatic transmission and a cooling and air filtration system.

The first application for the Euro Powerpack is in the re-engined Leclerc MBT the United Arab Emirates and the Giat Industries/Hagglunds Leclerc armoured recovery vehicle being developed as a private venture.

Studies have also shown that the MTU MT 883 V-12 diesel, rated at 1650 hp, with further growth potential, could be installed in the Vickers



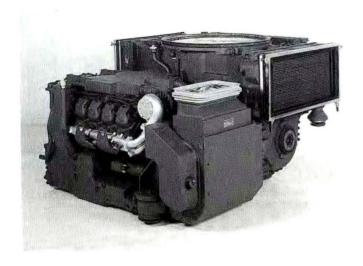
Prototype of the MTU powerpack MT 883 Ka-500 (Euro Powerpack) which includes a Renk transmission HSWL 295 TM, cooling and filtration system. Maximum output is 1500 hp at 2700 rpm

Defence Systems Challenger 2 and General Dynamics, Land Systems Division, M1A2 MBTs. According to MTU, such an installation would not only save a considerable amount of space which could be used for other purposes, but also increase the operational range of the tank as a result of improved fuel comsumption.

SPECIFICATIONS				
Model	MT 883	MT 882	MT 881	MT 880
TYPE		direct injection, 4-stroke, w	vet liners	
CONFIGURATION	90° V-12	90° V-10	90° V-8	90° V-6
CYLINDER DETAILS				
bore	144 mm	144 mm	144 mm	144 mm
stroke	140 mm	140 mm	140 mm	140 mm
DISPLACEMENT	27.41	22.8	18.2	13.71
COMPRESSION RATIO	14:1	14:1	14:1	14:1
FUEL SYSTEM		individual injection pumps at e	each cylinder	
ASPIRATION		2 turbochargers, 2 interco	olers	
RATING (max power)	1200 kW at 3000 rpm	1000 kW at 3000 rpm	800 kW at 3000 rpm	600 kW at 3000 rpm
LENGTH	1.56 m	1.47 m	1.175 m	0.985 m
WIDTH	0.97 m	0.97 m	0.97 m	0.97 m
HEIGHT	0.66 m	0.66 m	0.73 m	0.73 m
WEIGHT (dry)	1650 kg	1430 kg	1220 kg	1010 kg
APPLICATION	Euro Powerpack for	conceptual design only	prototypes of the 155 mm	conceptual design only
	prototype MBT		Panzerhaubitze 2000	
			prototype of Marder 2 IFV	

MTU Series 183 Engines

In 1988, MTU took over the responsibility for Mercedes-Benz engines to be used in armoured fighting vehicles. These engines are based on the OM 440 family which are produced in large quantities and typically installed in heavy trucks and buses. In this application they have proved to be very reliable.



MTU has applied its tank engine and powerpack knowledge to install these engines in armoured fighting vehicles. In order to give a good performance on slopes, a dry oil pan was introduced.

The engines of the 183 series are available as 6, 8 and 12-cylinder V-engines and cover a power range of 220 to 660 kW.

ODE	OIF	CAT	IONS
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Engine Model	6V 183	8V 183	12V 183
BASED ON MERCEDES-BENZ	Z		
MODEL	OM 441 LA	OM 442 LA	OM 444 LA
TYPE	direct injection.	4-stroke, wet lir	ners
CONFIGURATION AND			
NUMBER OF CYLINDERS	90° V-6	90° V-8	90° V-12
ASPIRATION	turbocharged a	and intercooled	
OUTPUT	294 kW	441 kW	662 kW
SPEED	2300 rpm	2300 rpm	2300 rpm
WEIGHT OF ENGINE, DRY	740 kg	890 kg	1215 kg
DISPLACEMENT	111	14.61	21.91
BORE/STROKE	128/140 mm	128/140 mm	128/140 mm

Manufacturer: MTU Motoren- und Turbinen-Union Friedrichshafen GmbH, D-7990 Friedrichshafen 1, PO Box 2040, Federal Republic of Germany. Telephone: 07541 90 2450 Telex: 734 280-0 mtd Fax: 07541 90 3922

MTU powerpack consisting of 12V 183 TE 22 diesel engine combined with ZF LSG 3000 automatic transmission, maximum output of 661 kW (900 hp) at 2300 rpm

MTU Powerpacks

Development/Description

In addition to the extensive range of diesel engines covered in the previous entry, MTU are also involved in the supply of complete powerpacks for installation in tracked armoured vehicles.

Most of these powerpacks are the responsibility of MTU. They are used in new vehicles as well as retrofitted in older vehicles.

A typical example is the powerpack for the AMX-30 MBT which has been developed by MTU in conjunction with ZF.

This new powerpack consists of the MTU MB 833 engine developing 850 hp (625 kW) coupled to a ZF LSG 3000 fully automatic transmission with integrated cooling and air filtration system. The cooling and air filtration systems were specially designed to meet all requirements, including that of operation in a desert environment.

The original AMX-30 brakes remain, but have been modified for improved reliability, as have the final drives.

The Turkish Army has a large fleet of 155 mm M44 and 105 mm M52 series self-propelled howitzers powered by an inefficient petrol engine. A German consortium of MTU, GLS and Rheinmetall developed a conversion kit which is now in series production for the Turkish Army.

Following trials with the prototype units, Turkey started a programme to convert its M44 to the upgraded M44T standard.

MTU powerpack for light armoured vehicles such as the M113 series APC

While some parts are coming from Germany much of the work is being carried out in Turkey. The first batch of MTU 833 Aa V-6 engines were assembled at Arifiye and the manufacturing agreement with MTU provides for the progressive increase in locally built parts in the future.

Using the 6, 8 and 12-cylinder 183 series engines, MTU has designed a series of powerpacks, mainly for front driven vehicles, but also for rear driven vehicles.

Examples of the front driven vehicles are the M113, ASCOD and AIFV (6V 183) TH 495, AV 90 and Trojan (8V 183) while the rear driven examples are the T-62 MBT and the T-54/T-55 MBT (12V 183).

Most of these programmes are already at the prototype stage and undergoing trials. According to MTU, they all feature compactness, reliability, low fuel consumption, ease of maintenance and the possibility of a quick change of the powerpack under field conditions.

MTU can now offer powerpack modernisation kits for the following vehicle types:

SPECIFICATIONS

AFV	Output
M113 series APC	300 hp
BMP-IFV	300 hp
M41 light tank	450 hp
M42 SPAAG	450 hp
M44 SPH	450 hp
M52 SPH	450 hp
M47 MBT	750 hp
M48A1, M48A2 MBT	750 or 1100 hp
M88 ARV	750 or 1100 hp
Vickers Mk I, II & III	750 hp
Vijayanta MBT	750 hp
T-54/T-55/T-62	750 hp
Type 59 MBT	750 hp
AMX-30 MBT	850 hp
M60 MBT	750 or 1100 hp
Chieftain	1100 hp
M1 MBT	1500 or 1630 hp
	1500 or 1630 hp
Challenger 2	
Leclerc	1500 or 1630 hp
Leopard 2	1500 or 1630 hp

Status: Production as required.

Manufacturer: MTU Motoren- und Turbinen-Union Friedrichshafen GmbH. D-7990 Friedrichshafen 1, PO Box 2040, Federal Republic of Germany. Telephone: 07541 90 2450 Telex: 734 280-0 mtd Fax: 07541 90 3922

Renk HSWL 194 Transmission

Development/Description

The Renk HSWL 194 hydromechanical power shift, reversing and steering transmission has four gears forward and reverse and can be operated fully and semi-automatically. This transmission is installed in the Marder 1 IFV and Roland 2 surface-to-air missile systems used by the German Army.

The transmission can be mounted directly to the engine or via a connecting component. The output shafts are transverse to the input.

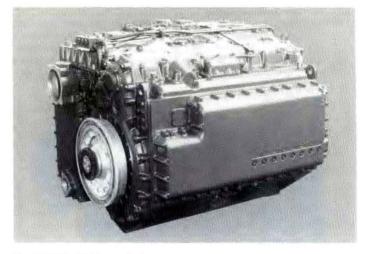
Propulsion drive is via a torque converter with lock up clutch, shifting and reversing gear to be shifted under load with planetary gear sets, multi-disc brakes and clutches. Steering drive is infinitely variable by a hydrostatic-hydrodynamic superimposed steering system.

As an additional brake on slopes a hydrodynamic retarder is installed. The central oil supply consists of a built-in reservoir, pumps, filters, valves and oil heat exchanger.

Controls include electric remote-control for gearshifting and reversing, mechanical or hydraulically actuated steering, mechanical actuating of the emergency drive second gear forward and reverse when current fails.

A power take-off is provided to connect the hydraulic pump for the vehicle brake system.

Options for the HSWL 194 transmission include an external testing device, brake actuating system, sprocket drums, transmission suspension, connecting cable between gear selector, electronic control unit, transmission and vehicle, operating and output gear-type couplings, parking brake and final drives.



Renk HSWL 194 transmission

Status: Production.

Manufacturer: Renk AG, Gögginger Strasse 73, D-8900 Augsburg, Federal Republic of Germany.

Telephone: 0821 5700 221 Telex: 53781 Fax: 0821 5700 595

SPECIFICATIONS		GEAR RATIOS		HEIGHT	815 mm
ENGINE POWER RANGE	450-550 kW	first	3.55	POWER TAKE OFF	5 kW
ENGINE SPEED RANGE	2200-3000 rpm	second	1.82	HYDRODYNAMIC	
MAX VEHICLE WEIGHT	35 t	third	1.22	RETARDING,	
WEIGHT OF TRANSMISSION	N	fourth	0.82	BRAKING POWER	180-220 kW
without oil	1250 kg	LENGTH	1040 mm	OPERATING VOLTAGE	24 V/28 V
NUMBER OF GEARS	4 forward, 4 reverse	WIDTH	1115 mm		

Renk HSWL 284 Transmission

Development/Description

The Renk HSWL 284 transmission is a hydromechanical power shift, reversing and steering transmission with four gears forward and reverse and was installed in the now cancelled 155 mm SP-70 and various trials vehicles such as a new German fast mineclearing tank.

The transmission can be operated fully automatically or semi-automatically and can be mounted to the engine directly or via a connecting component. The output shafts are transverse to the input.

Propulsion drive is via a torque converter with lock up clutch, shifting and reversing gear to be shifted under load with planetary gear sets, multi-disc brakes and clutches.

Steering drive is infinitely variable by a hydrostatic-hydrodynamic superimposed steering system. The transmission brake is a hydrodynamic retarder at the transmission output shaft as part of the vehicle brake system.

Controls include electric remote-control for gearshifting and reversing, mechanically or hydraulically actuated steering, mechanical actuating of the emergency drive second forward gear and reverse gear when the current fails. A power take off from one of the two cooling fans is provided.

Options for the HSWL 284 automatic transmission include connecting cable between gear selector, electronic control unit, transmission and vehicle, output gear-type couplings, final drives, sprocket drums, brake actuating system and external testing device.

Variants

The latest versions are the HSWL 284 C and the HSWL 294. The former has been installed in both prototypes of the Panzerhaubitze 2000 built to meet the requirements of the German Army, 155 mm PzH 2000 self-propelled howitzer system in an L-powerpack configuration. Prototypes for transverse-mounted powerpacks are under consideration. The HSWL 294 will also be installed in a Chieftain MBT as a retrofit kit.



Renk HSWL 284-C transmission

The design of the HSWL 284 C and the HSWL 294 is similar, with the former rated at a maximum of 900 kW and the latter at 1100 kW respectively. They also have power take-offs for driving the cooling fans which incorporate hydrodynamic couplings. These can be used to disconnect the fans when a vehicle accelerates thereby reducing very significantly the drag due to the inertia of its rotating parts, in addition to providing infinitely variable control of the fan speed. The combined brake system (retarder, service and parking brake) including the hydraulic control, is arranged at the transmission.

SPECIFICATIONS		GEAR RATIOS		POWER TAKE OFF	
ENGINE POWER RANGE	600-900 kW	first	4.99	cooling fan	125 kW
ENGINE SPEED RANGE	2200-3000 rpm	second	2.42	HYDRODYNAMIC	
MAX VEHICLE WEIGHT	60 000 kg	third	1.62	RETARDER	
WEIGHT OF		fourth	1.05	MAX BRAKE TORQUE	24 000 Nm
TRANSMISSION		LENGTH	950 mm	OPERATING VOLTAGE	24 V/28 V
without oil	1750 kg	WIDTH	1530 mm		
NUMBER OF GEARS	4 forward, 4 reverse	HEIGHT	690 mm		

Status: Production as required.

Manufacturer: Renk AG, Gögginger Strasse 73, D-8900 Augsburg, Federal Republic of Germany.

Telephone: 0821 5700 221 Telex: 53781 Fax: 0821 5700 595

Renk HSWL 354 Transmission

Development/Description

The HSWL 354 is a hydromechanical power shift, reversing and steering transmission with four forward and two reverse gears and is installed in the Leopard 2, Leopard 2 driver training vehicle, Armoured Recovery Vehicle 3 and Vickers Mk 7 MBT.

Operation is fully and semi-automatic and the transmission can be mounted to the engine directly or via a connecting component. Mechanical brakes are built on to the output shafts which are transverse to the input.

Propulsion drive is via a torque converter with lock up clutch, shifting and reversing gear to be shifted under load with planetary gear sets, multi-disc brakes and clutches.

Steering drive is infinitely variable by a hydrostatic-hydrodynamic superimposed steering system.

The transmission brake is a combined hydrodynamic-mechanical brake system as service brake, without parking and auxiliary brakes.

The central oil supply consists of a built-in reservoir, pumps, filters and valves. A connection for the oil heat exchanger is provided.

Controls consist of an electric remote-control for gearshifting and reversing; mechanical actuation of steering, service brake and emergency drive second gear forward and reverse when the current fails. Power take off is from the two cooling fans.

Options for the HSWL 354 transmission include connecting cable between gear selector, electronic control unit, transmission and vehicle, output geartype couplings, final drives, sprocket drums and external testing device.

SPECIFICATIONS

0. 2011 1071110110	
ENGINE POWER RANGE	900-1300 kW
ENGINE SPEED RANGE	2200-3000 rpm
MAX VEHICLE WEIGHT	70 000 kg
WEIGHT OF TRANSMISSION	-
without oil	2250 kg
NUMBER OF GEARS	4 forward, 4 reverse
GEAR RATIOS	

 first
 4.50

 second
 2.21

 third
 1.52

 fourth
 1



Renk HSWL 354 transmission

OPERATING VOLTAGE

LENIOTH

LENGTH	1040 mm
WIDTH	1720 mm
HEIGHT	780 mm
POWER TAKE OFF	
two cooling fans	150 kW
TRANSMISSION BRAKE	
SYSTEM, MAX	
BRAKE TORQUE	25 000 Nm

Status: Production. By January 1993 over 3000 of these transmissions had been completed.

1010

24 V/28 V

Manufacturer: Renk AG, Gögginger Strasse 73, D-8900 Augsburg, Federal Republic of Germany.

Telephone: 0821 5700 221 Telex: 53781 Fax: 0821 5700 595

Renk RK 304 Transmission

Development/Description

The RK 304 is a hydromechanical power shift, reversing and steering transmission and is used in new powerpacks installed in M48, M60 and Centurion tanks, OTO Melara Palmaria 155 mm self-propelled howitzer (coupled to MTU diesel) and the Arjun Indian MBT.

The transmission can be attached to the engine directly or via an intermediate structure. The service and parking brakes are arranged on the two transmission output shafts positioned transversely to the input drive.

The connection to the final drives can be made via disconnectable geartype couplings or via universal joints. Two mounting points are arranged on the transmission for a three-point support of the powerpack.

The two-radii superimposed steering transmission is infinitely variable in the large radius range.

Dry running disc brakes at both output shafts act as service and parking brakes respectively. Static braking torque per side is 12 000 Nm. The electrically operated retarder at the transmission input side is electrically actuated with a continuous brake power of 225 kW. The power take-off is primary side driven, not disconnectable, with a maximum output of 110 kW.

Variant

Renk RK 304 transmission with two fan drives on top, infinitely speed controlled. This transmission is suitable for front or rear drive and allows the vehicle to be tow started.

Options for the RK 304 transmission include connecting cable between gear selector, electronic control unit, transmission and vehicle, output gear-type couplings, final drives, sprocket drums, brake actuating system and an external testing device.



Renk RK 304 transmission

Status: Production. By January 1993 over 1500 of these transmissions had been completed.

Manufacturer: Renk AG, Gögginger Strasse 73, D-8900 Augsburg, Federal Republic of Germany.

Telephone: 0821 5700 221 Telex: 53781 Fax: 0821 5700 595

SPECIFICATIONS		STALL TORQUE RATIO	approx 2.6	WIDTH	770 mm
ENGINE POWER RANGE	600-1100 kW	NUMBER OF GEARS	4 forward, 4	HEIGHT	965 mm
ENGINE SPEED RANGE	2200-3000 rpm		reverse	POWER TAKE OFF	110 kW
MAX VEHICLE WEIGHT	60 000 kg	GEAR RATIOS		OPERATING VOLTAGE	24-28 V DC
WEIGHT OF TRANSMISSIO	N	first	4.55		
without oil	1750 kg	second	2.21		
TORQUE CONVERTER	two-stage turbine	third	1.47		
	with mechanical	fourth	0.95		
	lock up	LENGTH	1610 mm		

Renk HSWL 106 Transmission

Development/Description

This is basically similar to the earlier Renk transmissions but incorporates a range pack with six speeds that can be used in reverse as well as forward, instead of the four speeds. As it is intended for lighter vehicles, its steering drive is also of the purely hydrostatic type and its hydraulic retarder is upstream of the range pack. In addition it has been designed to be adaptable to installations in the front or rear of vehicle hulls. The HSWL 106 is rated up to a maximum of 450 kW.

SPECIFICATIONS

ENGINE POWER RANGE 300-450 kW ENGINE SPEED RANGE 2200-3000 rpm MAX VEHICLE WEIGHT WEIGHT OF TRANSMISSION without oil 1050 kg NUMBER OF GEARS 6 forward, 6 reverse GEAR RATIOS first 5.30 second 3.64 third 2.53 1.74 fourth 1.21 fifth sixth 0.83 LENGTH 850 mm WIDTH 1065 mm HEIGHT 800 mm POWER TAKE OFF 70 kW HYDRODYNAMIC RETARDING: **BRAKING POWER** 350 kW



Renk HSWL 106 transmission

Status: Development complete. Ready for production. Installed in prototypes of the private venture MARS 15 light armoured vehicle developed by Mecanique Creusot-Loire.

Manufacturer: Renk AG, Gögginger Strasse 73, D-8900 Augsburg, Federal Republic of Germany

Telephone: 0821 5700 221 Telex: 53781 Fax: 0821 5700 595

Other Renk Tank Transmissions

HSWL 96

OPERATING VOLTAGE

This is currently under development and is similar to the HSWL 106 but is rated at up to 300 kW instead of 400 kW.

24 V/28 V

This is a further development of the HSWL 194 and has been designed for tracked vehicles with a power output of between 500 and 600 kW. It has been produced in quantity for the Argentine TAM and VCTP vehicles.

This has been designed for engines of 500 to 650 kW and is used for repower packages for the French AMX-30 MBT.

HSWL 290

This is a member of the new generation of transmissions from Renk that includes the HSWL 186, HSWL 106 (qv) and the HSWL 96. The HSWL 290 is designed for use with engines rated from 671 to 894 kW (900 to 1200 hp).

HSWL 186

This is a member of the new generation of transmissions from Renk that includes the HSWL 290, HSWL 106 (qv) and the HSWL 96. The HSWL 186 is designed for use with engines rated from 372 to 753 kW (500 to 1100 hp).

Status: Production as required.

Manufacturer: Renk AG, Gögginger Strasse 73, D-8900 Augsburg, Federal

Republic of Germany

Telephone: 0821 5700 221 Telex: 53781 Fax: 0821 5700 595



HSWL 204 transmission HSWL 224 transmission

Renk Transmissions For Heavy Wheeled Vehicles

Development/Description

Renk's five, six and seven gear automatic transmissions have been developed specifically to meet the requirements of heavy wheeled armoured vehicles. The production range comprises a complete family of transmissions designated HS and WR-PS designed for use with engines having an output of 240 kW to 735 kW and a maximum possible engine torque of 3000 Nm.

The modular design for the HS transmission family gives vehicle manufacturers a high degree of flexibility in their powerpack and drive train arrangement.

The automatic transmission is equipped with a hydrodynamic torque converter which also serves as a retarder. This relieves the wheeled brakes, which are subjected to very high thermal loads in heavy vehicles.

Shifting of the automatic transmission, as well as the monitoring and control of other driveline components, is effected via a central electronic control unit.

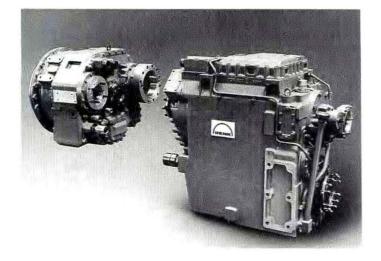
A typical example is the German Daimler-Benz 8 x 8 armoured vehicle developed as a private venture and fitted with a Leopard 1 turret armed with a 105 mm gun. This has a combat weight of 31 tonnes and is powered by a Daimler-Benz OM 444 LA diesel engine developing 750 hp (552 kW) at 2100 rpm which gives a maximum road speed of about 100 km/h. The engine is coupled to a Renk fully automatic transmission type HS 226 combined with a transfer gear type V09.

Status: Production as required.

Manufacturer: Renk AG, Gögginger Strasse 73, D-8900 Augsburg, Federal

Republic of Germany

Telephone: 0821 5700 221 Telex: 53781 Fax: 0821 5700 595



Renk WR-PS fully automatic transmission

Renk HS fully automatic transmission

ZF LSG 3000 Transmission

Development

The LSG 3000 automatic power shift transmission has been designed as a private venture by ZF and entered production in 1984. By late 1992 over 700 LSG 3000 transmissions had been completed and licence manufacture was also underway in South Korea. Late in 1990 about 20 per cent of the transmission was being built in South Korea with the remainder still coming from Germany, but as time goes on the local production content is expected to increase.

The LSG 3000 has been installed in private venture Giat Industries AMX-40 MBT and in the AMX-30 MBT in Spain where it is produced under licence by Bazan for the repowering programme. The LSG 3000 has also been selected by Italy for its new C1 MBT. It has been designed for installation in tracked vehicles with a maximum power output of 1100 kW.

Description

The LSG 3000 is an integrated system with the gear changing mechanism and steering gear accommodated within the same casing. Pre-assembled and tested assemblies are introduced into the one-piece casing through large openings and bolted in position. Replacement or servicing of any assembly can be accomplished very quickly

This transmission has been designed for front and rear drive applications as two differently shaped casings and various facilities at the input end make this transmission adaptable to all driveline configurations.

The LSG 3000 has four forward and two reverse gears and the converter operates with lock up clutch in all gears to eliminate slip losses. A secondary retarder is incorporated in the LSG 3000 and this takes up most of the braking force. Mechanical brakes respond only at lower speeds when the effect of the retarder reduces

The LSG 3000 has a superimposed mechanical three-radius steering unit and an infinitely variable range. At high speeds a sensitive infinitely variable steering is possible. At lower speeds and on rough terrain the fixed radii are engaged. By this combination the efficiency of the transmission is improved. This steering unit can transmit full power down to vehicle halt.

Central and sidemounted PTOs are available for fan drives and these operate at different levels to suit individual cooling requirements.



ZFLSG 3000 fully automatic transmission cutaway to show main components

The electronic gear change control system is housed within a heavy duty metal housing providing maximum protection against electromagnetic interference and mechanical shocks up to 10g. The gear change programme is matched to the vehicle and gearbox parameters including the number of gears, transmission ratios, and road and load conditions.

The final drive unit P 25 000 completes the full selection of LSG 3000 driveline units and its epicyclic gears are capable of multiplying the gearbox torque by a ratio of 1:4.67

Status: Production.

Manufacturer: ZF Friedrichshafen AG, Friedrichshafen Division, Postfach 2520, D-7990 Friedrichshafen 1, Federal Republic of Germany Telephone: 0 7541 770 Telex: 734 207-0

SPECIFICATIONS MAX ENGINE POWER MAX ENGINE TORQUE MAX RETARDER TORQUE WEIGHT OF BASIC TRANSMISSION		ENGINE SPEED	adaptation to different engine speeds by means of variable input drive units	GEAR RATIOS 1st forward 2nd forward 3rd forward 4th forward 1st reverse	4.64 2.6 1.667 1
TRANSMISSION	1500 kg		dillo	1st reverse	4.46
MAX GROSS VEHICLE				2nd reverse	1.4
WEIGHT	60 000 kg (approx)				

ZF LSG 2000 Transmission

Development

The LSG 2000 transmission has been designed as a private venture by ZF and is a member of a family of fully automatic transmissions that also includes the LSG 3000, LSG 1500 and the LSG 1000.

The LSG 2000 is already in volume production for installation in the Vickers Shipbuilding and Engineering 155 mm AS90 self-propelled artillery system ordered by the British Army in mid-1989. First production AS90s were completed for the British Army in 1992.

Description

The LSG 2000 is of modular design and construction for installation in medium-duty tracked vehicles with an input power of up to 737 hp (550 kW).

It is composed of nine separate operational modules each of which is separately assembled and installed in the transmission housing. A number of additional units/accessories are available including an engine connection flange/flexible coupling, speed range selector SGK-W, electronic automatic shift control unit AEM-6M, compact cable harness, steering linkage, actuating device for emergency gear shift, oil cooler, load sensor for pressure modulation, starter interlock for steering gear, speedometer including mounting kit, fan pump and final drive and brake.

The LSG 2000 has a torque converter with lock up clutch and automatically controlled epicyclic gear train that provides four forward and two reverse speeds, although alternative sets of gears can provide up to eight forward speeds if required. It also incorporates a hydrodynamic retarder.

The main advantages of the LSG 2000 are as follows:

- (a) assembly and disassembly of the complete unit is highly flexible
- (b) it can be tailored to suit engines and tracked vehicles across the appropriate performance range
- (c) it is suitable for installation in front and rear drive vehicles
- (d) it has a wide range of ratios possible to adapt the transmission to different engine speed ranges and vehicle speeds
- (e) adaptation of input ground by means of variable distance between transmission and engine centres in both horizontal and vertical planes
- (f) various versions of flange-mounted fan pump
- (g) torque converter locked up in uneconomic operating range in all gears
- (h) hydrodynamic primary retarder relieves the load on the mechanical brakes
- (i) extended maintenance intervals for the service brakes
- (j) easy to operate as it has automatic shifting cycles
- (k) economic operation by versatile microprocessor controlled drive programme
- (I) pivot turning capability
- (m)high manoeuvrability due to hydrostatic mechanical superimposed steering gears. This combination enables infinitely variable steering at higher speeds and fixed radii for low speeds or on rough terrain with high efficiency.

Variants

The LSG 1500 is similar to the LSG 2000 but has a different capacity and a different steering system. The LSG 1500 fully automatic transmission has been installed in the private venture Krupp MaK Armoured Vehicle 90

announced in 1988. The LSG 1500 has a hydrostatic steering system while the LSG 2000 has a dual steering drive with a hydrostatic stage followed by a mechanical stage.

SPECIFICATIONS		
Version	LSG 2000	LSG 1500
MAX ENGINE POWER	737 hp (550 kW)	536 hp (400 kW)
MAX ENGINE TORQUE	2700 Nm	2000 Nm
RETARDER TORQUE	1200 Nm	1200 Nm
WEIGHT	1350 kg	1150 kg
MAX GROSS VEHICLE		
WEIGHT	36 000 kg	22 000 kg
ENGINE SPEED	adaptation to different	engine speeds by means
	of variable drive units	
GEAR RATIOS		
1st forward	4.15	4.15
2nd forward	2.36	2.36
3rd forward	1.57	1.57
4th forward	1	1
1st reverse	4.52	4.52
2nd reverse	1.38	1.38

Status: LSG 2000 in production for 155 mm AS90 self-propelled artillery system. LSG 1500 still at prototype stage.

Manufacturer: ZF Friedrichshafen AG, Friedrichshafen Division, Postfach 2520, D-7990 Friedrichshafen 1, Federal Republic of Germany. Telephone: 0 7541 770 Telex: 734 207-0



ZF LSG 2000 fully automatic transmission cutaway to show position of main components

ZF LSG 1000 Transmission

Development

The LSG 1000 transmission has been designed as a private venture by ZF and is a member of a family of fully automatic transmissions that also includes the LSG 3000, LSG 2000 and the LSG 1500 which are covered in previous entries.

It has been designed for front-end installation in lightweight tracked vehicles weighing up to 17 tonnes with a maximum engine output of 375 hp (280 kW).

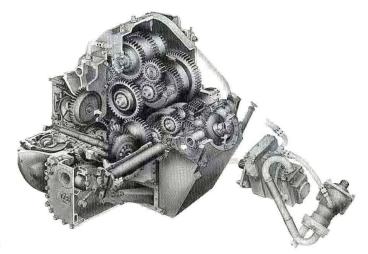
For trials purposes it has already been installed in an M113 series APC coupled to an MTU 6V 183 TC22 engine (gv).

By 1992 a total of 15 LSG 1000 automatic transmissions had been built by ZF and development was complete. Trials of an M113 fitted with an MTU engine coupled to a ZF LSG 1000 transmission have been completed by the German Army.

Description

The main advantages of the LSG 1000 are as follows:

- (a) it can be tailored to suit a wide range of engines and tracked vehicles across the performance range
- (b) input ratios can be adapted to suit different speeds of engine and vehicles
- (c) it can be fitted with a PTO unit for fan pump
- (d) greater vehicle mobility due to wide ratio range and high overall efficiency
- (e) it has a torque converter lock up to avoid uneconomic operating range in all gears
- (f) there is option to fit a service and parking brake assembled with the transmission which avoids excessive stresses and errors in turning radius during simultaneous steering and braking



Cutaway drawing of ZF LSG 1000 fully automatic transmission showing position of main components

- (g) easy to operate transmission system due to automatic gear change sequences and a consequent improvement in driver efficiency
- (h) economic operation by versatile microprocessor controlled drive programme

MAY GROSS VEHICLE

- good mobility combined with ease of operation due to infinitely variable hydrostatic superimposed steering gear
- (j) pivot turning capability
- (k) consistent response to steering controls irrespective of direction of travel
- (I) the engine can be tow started.

In addition to the hydrostatic fan drive, a variety of auxiliary units/ accessories is available including an oil cooler, final drive, servicing and parking brake, brake control, fan pump drive, engine connection flange/ flexible coupling, speed range selector, electronic automatic command unit, compact cable harness, steering control, actuating device for emergency gear change, engine load sensor, engine starter interlock and speedometer with mounting kit.

SPECIFICATIONS

MAX ENGINE POWER
MAX ENGINE TORQUE
WEIGHT

375 hp (280 kW) 1400 Nm 650 kg

MAX GHOSS VEHICLE	
WEIGHT	16 000 kg
ENGINE SPEED	adaptation to different engine speeds by means of variable drive
GEAR RATIOS	
1st forward	5.85
2nd forward	3.82
3rd forward	2.54
4th forward	1.65
5th forward	1.15
6th forward	0.75
1st reverse	5.85
2nd reverse	2.54
3rd reverse	1.15

Status: Prototype tested in M113 series APC.

Manufacturer: ZF Friedrichshafen AG, Friedrichshafen Division, Postfach 2520, D-7990 Friedrichshafen 1, Federal Republic of Germany. Telephone: 0 7541 770 Telex: 734 207-0

Other ZF Automatic Transmissions

ZF Friedrichshafen AG supplies the following automatic transmissions for armoured vehicles:

ZF 4 HP 220

This compact automatic transmission has four forward and one reverse gear and has been designed for installation in light vehicles such as the Wiesel, Ogum and VBL.

ZF 6 HP 500/600

This is installed in the Transportpanzer 1 (6 \times 6) vehicle. Three coupled epicyclic gear assemblies acting together with three rotating multi-disc clutches and three multi-disc brakes give six forward and one reverse gears.

ZF HP 1500/2000

5-8 speed power shift gearbox for 6×6 and 8×8 driveline configurations. Already installed in heavy fire-fighting vehicles and APC/AFV, covering a power range from 450-830 hp. The HP 1500 is installed in the Italian Centauro 8×8 105 mm tank destroyer ordered by the Italian Army and with first production vehicles being completed in 1990.

Manufacturer: ZF Friedrichshafen AG, Friedrichshafen Division, Postfach 2520, D-7990 Friedrichshafen 1, Federal Republic of Germany.

Telephone: 0 7541 770 Telex: 734 207-0



ZF HP 1500 transmission which is installed in the Centauro 8 \times 8 105 mm tank destroyer of the Italian Army

ISRAEL

NIMDA Retrofit Powerpacks

Developmen

NIMDA has designed and built to the prototype stage the Shoet (6 \times 6) troop carrier, details of which were given in *Jane's Armour and Artillery 1985-86*, page 307. NIMDA concentrates on the modernisation of tracked and wheeled armoured fighting vehicles in the three key areas of armour, mobility and fire-power. The company is supported by the Detroit Diesel Corporation and NIMDA's associate company, Diesel Engineering Limited, is the Israeli distributor for Allison Transmission as well as the AC Delco Division of General Motors.



M113 APC upgraded by NIMDA to M113A3 standard with new powerpack and additional armour protection

AMX-13 light tank

The company has also modified an AMX-13 light tank by replacing its petrol engine with the Detroit Diesel 6V-53T developing 300 hp at 2800 rpm, and installing a new NIMDA designed automatic transmission specifically to fit the existing hull.

The vehicle also has an Elbit Lancelot fire-control system which incorporates a laser rangefinder, digital computer and a second generation image intensifier sight. As the Israeli Army no longer operates the AMX-13 light tank this is aimed specifically at the export market.

Other options for the AMX-13 include different armament installations (60 mm, 90 mm or 105 mm), a fire extinguishing system and add-on armour. The automotive conversion is also applicable to other members of the AMX-13 light tank family.



PT-76 light tank modernised by NIMDA with 90 mm gun and many other improvements

Centurion

Modernisation package includes the installation of a new diesel powerpack, consisting of a 12-cylinder diesel developing 900 hp coupled to a CD-850 automatic transmission, and new gun control equipment, upgunning to 105 mm, new fire-control and optical systems and installation of other key subsystems such as add-on armour and a new suspension system.

Sherman

Modernisation package includes installation of a new diesel powerpack, installation of a TAAS - Israel Industries Ltd 60 mm HVWS, covered in the *Armoured Fighting Vehicle Armament* section and a new fire-control system. A quantity of Shermans upgraded to this standard has been exported to an undisclosed country.

M41 light tank

Basic modernisation package includes a new powerpack with the option of replacement of 76 mm gun by 60 mm HVWS, new fire-control system, new optics and other key subsystems.

M24 light tank

Modernisation package includes new powerpack, installation of new main armament, new fire-control system, new optics and other key subsystems.

PT-76 light amphibious tank

The modernisation package includes the installation of a new Detroit Diesel 6V-92T developing 270 hp coupled to the original Soviet manual transmission with a new clutch assembly; as an alternative, the NIMDA N-302 transmission can be installed. The kit also includes a 24 V 200 Ah alternator, new cooling and electrical systems and fuel, exhaust, air inlet, hull and top deck modifications.

The original 76 mm gun has been replaced by a 90 mm weapon that can fire a wide range of ammunition including APFSDS. The 7.62 mm coaxial machine gun has been replaced by a NATO 7.62 mm machine gun and a similar weapon can be mounted on the turret roof for anti-aircraft defence. Smoke dischargers can be installed on either side of the turret if required.

To improve first round hit capability, a new fire-control system has been installed together with a new day/night sight for the gunner that also incorporates a laser rangefinder.

A new solid state all-electric gun/turret stabilisation and power control system has replaced the original Soviet system and a new fire extinguishing system has also been installed.

MBT Powerpack

In 1991 NIMDA stated that it had developed an 850 hp powerpack for installation in a wide range of MBTs including the French AMX-30 and the former Soviet T-54/T-55 and T-62.

The new powerpack comprises the Detroit Diesel Model 8V-92TA with Detroit Diesel Electronic Control II (DDEC), Allison XTG 411 transmission with Allison Transmission Electronic Control (ATEC) I, cooling system and connection group.



The engine features low heat rejection heads, high efficiency turbochargers, air change aftercooler/intercooler combustion and a mechanically driven positive displacement blower with bypass system.

The microprocessor-controlled DDEC II system gives the engine a number of advantages including reduction of smoke and noise during vehicle acceleration, improved acceleration under combat conditions, faster engine warm-up combat readiness, reduced start time at low ambient temperatures and self-diagnosis. The transmission has four forward and two reverse gears with the ATEC I controller providing lower fuel consumption, reduced overheating problems, improved transmission reliability and longer operating life, easier driver training and self-diagnosis.

The HAC cooling system is integrally mounted on the powerpack. An electronic control device communicates with both the DDEC II and the ATEC I

The powerpack is fitted with a 650 amp Bendix alternator which is already fitted to a number of MBTs such as the M1 and M60.

Like former Soviet MBTs, an MBT fitted with the new NIMDA powerpack can lay its own smoke screen by injecting diesel fuel into its exhaust pipes.

SPECIFICATIONS

LENGTH	142 cm
WIDTH	99 cm
HEIGHT	107 cm
WEIGHT	1042 kg
OUTPUT	850 bhp at 2300 rpm

M113A1/M113A2

Existing M113 series APCs can be fitted with new diesel powerpacks in the 216/265 hp range and in addition an improved cooling system has been introduced.

M113A3

This is the latest modification package and includes the retrofit of powerpacks in the 275 to 300 hp range, improved protection, improved suspension, automatic fire extinguishing system, external fuel tanks, NBC system and new remotely operated 7.62 mm machine guns.

BTR-50 Amphibious APC

This repower package is similar to that of the PT-76 but the vehicle also has new day and night observation equipment and if required new armament installation. The latter includes a bow-mounted machine gun to provide suppressive fire over the frontal arc, two roof-mounted 7.62 mm machine guns and option of passive night vision equipment for commander, gunner and driver.

HWK-11 APC

It is believed that at least one of the Mexican army's HWK-11 APCs has been upgraded with a new diesel engine coupled to an automatic transmission and other subsystems replaced. Mexico is the only user of the HWK-11.

Half-track APC

The retrofit programme includes a complete repowering kit, optional fully automatic transmission, reconditioning kit and various optional armament installations.

MWMBT

At present the company is designing the Medium Weight Main Battle Tank which will be fitted with a modern powerpack, 105 mm or 120 mm main armament with advanced fire-control systems and optics and a turret drive and stabilisation system.

Status: Prototypes built and approved.

Manufacturer: NIMDA Company Ltd, 1 Korazin Street, IL-53583 Givatayim,

PO Box 20072, Tel Aviv, Israel.

Telephone: (03) 5712161 Telex: 0341457 NIM IL Fax: (03) 5715022

NIMDA MBT powerpack ready for installation in vehicle with transmission in foreground, engine to rear and hinged radiators on the right

SPECIFICATIONS

Vehicle	Engine	Engine
	type	hp
AMX-13	6V-53T	300
Centurion	12V92QTA	900
Sherman	8V-71T	475
M41	8V-71T	470
M24	6V-53T	300
T-54/T-55	8V-92TA	850
M3 half-track	6V-53	172
BTR-50	6V-92T	270
PT-76	6V-92T	270
AMX-30	12V92QTA	830

Transmission	Max Road	Max Range
(automatic)	speed	
N-303	60 km/h	550 km
CD-850	45 km/h	450 km
non-automatic	41 km/h	420 km
CD 500-3	70 km/h	420 km (note A)
MT-653	48 km/h	450 km
XTG-411	n/av	n/av (note B)
TX-100	72 km/h	500 km
N-302	51 km/h	250 km
N-302	51 km/h	250 km
CD-850	n/av	n/av

lax Road peed	Max Range	
/av	n/av	
/av	485 km	
lav	485 km	

Vehicle	Engine	Engine	Transmission	Max Road	Max Range
	type	hp	(automatic)	speed	
M113A1	6V-53N	216	TX-100	n/av	n/av
M113A2	6V-53T	265	TX-100-1A	n/av	485 km
M113A3	6V-53T	300	X-200-4	n/av	485 km
V-100/V-150	8.2L	205	AT-545	n/av	n/av
NIMDA MBT	12V92QTA	1200	X-1100-5	n/av	n/av
HWK-11	6V-53	210	TX-100	60 km/h	400 km

Notes:

- Also available with 6V-92T engine developing 470 hp coupled to X-300 or CD-500-3 automatic transmission
- Also applicable to T-62 and AMX-30 MBTs

RAFAEL Upgrading of Combat Vehicles

Development/Description

Building on their extensive experience in the design, development and upgrading of armoured fighting vehicles and subsystems, the Field Systems Department of RAFAEL are now offering to upgrade armoured fighting vehicles for other defence forces.

Typical areas of upgrading include:

Armour protection and survivability: This includes lightweight passive and explosive reactive armour for increased survivability and the integration of sophisticated deception technologies including automatic fire extinguishers and fire resistant ammunition cases.

Overhead weapon stations: This has been fully developed and can be fitted with light and medium calibre machine guns onto any circular opening with a diameter from 430 mm upwards. The gunner can operate the weapon from inside or outside the vehicle depending on the operational requirements.

Electro-optical sensors: These include thermal, optical and TV sensors for target observation, acquisition and aiming under both day and night conditions and under all weather conditions. The optical modules can be installed on a folding or quickly erected mast or suspended from a helium filled Observation Balloon System (OBS) deployed from the vehicle.

Launchers: For rockets, missiles or grenades, independently operated or slaved to a remote-control system.

This covers improvements to the power Automotive improvements: train and suspension systems to accommodate additional weight, added power or changes in dimensions.

Command and control: This includes the installation of such systems as the heading reference system or mission planning systems.

Detailed information on some of the extensive range of RAFAEL subsystems are given in the relevant sections of Jane's Armoured Fighting Vehicle Retrofit Systems, including the following:

Explosive reactive armour

Toga passive add-on armour

Screen obscurant smoke system Overhead weapon station

RAFCOM-1 heading reference system

Periscopic view sight NITE LITE target acquisition system.

Status: Production as required.

Manufacturer: RAFAEL, PO Box 2250/80, IL-31021 Haifa, Israel. Telephone: 972 4 794784 Telex: 471508 VERED IL Fax: 972 4 494703

ITALY

IVECO FIAT Family of Diesel Engines

Development/Description

IVECO FIAT has developed a new family of four-stroke, diesel/multi-fuel, direct injection, turbocharged and intercooled engines in V-6, V-8 and V-12 configurations for installation in the new family of armoured fighting vehicles for the Italian Army

These utilise commercial components to reduce both procurement and life-cycle costs. The commercial engines have been militarised in a number of areas including the ability to operate in high longitudinal/lateral slopes, high temperatures and multi-fuel operations in extreme environmental conditions. They also have increased specific power with boosted supercharging integrated by feeding air cooling (aftercooling).

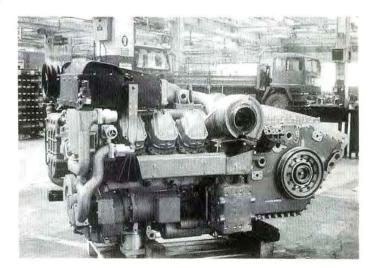
The complete powerpack comprises the engine, transmission, air filter assembly, cooling group and the exhaust group.

Building on its experience in the manufacture of the 4 HP 250 transmission for the Italian built Leopard 1 MBTs, IVECO FIAT is proposing the German ZF LSG 1500, 2000 and 3000 automatic transmissions for use with their

The V6M TCA is already in production for the B1 Centauro (8 \times 8) tank destroyer and in this application is coupled to a ZF 5 HP-1500 transmission. The V6M TCA is also installed in the prototypes of the OTO Melara VCC-80 infantry fighting vehicle and in this application is coupled to a ZF LSG 1500 transmission. The V12M TCA, coupled to a ZF LSG 3000 automatic transmission is installed in the six prototypes of the OTO Melara C1 Ariete



Powerpack for the C1 Ariete MBT consists of the IVECO FIAT V12M TCA V-12 diesel developing 1200 hp coupled to the ZF LSG 3000 automatic transmission



Powerpack for the VCC-80 infantry fighting vehicle which includes the IVECO FIAT V6M TCA engine developing 600 hp at 2300 rpm

SPECIFICATIONS			
Model	V6M TCA	V8M TCA	V12M TCA
NUMBER OF CYLINDERS	V-6	V-8	V-12
BORE	145 mm	145 mm	145 mm
STROKE	130 mm	130 mm	130 mm
TOTAL DISPLACEMENT	12.881	17.17	25.75
COMPRESSION RATIO	13.5:1	13.5:1	13.5:1
RATED POWER (hp/kW)	600/441	800/588	1200/882
RATED RPM	2300	2300	2300
MAX TORQUE/RPM	190 kgm/1600	268.5 kgm/1600	434 kgm/1600
DRY WEIGHT	1230 kg	1550 kg	2180 kg
ALTERNATOR	9-15 kW	9-15 kW	9-15 kW
WEIGHT/POWER RATIO	2.05 kg/hp	1.93 kg/hp	1.81 kg/hp

Model POWER/DISPLACEMENT	V6M TCA	V8M TCA	V12M TCA
RATIO	46.6 hp/l	46.6 hp/l	46.6 hp/l
TRANSMISSION	LSG 1500	LSG 2000	LSG 3000
APPLICATION	VCC-80	B1 (8 × 8)	C1 Ariete

Status: All of the these engines/powerpacks have been installed in prototype vehicles but as of February 1993 only the B1 Centauro (8×8) 105 mm armed tank destroyer had entered production for the Italian Army. Under current plans a total of 400 Centauro vehicles is to be built for the Italian Army.

Manufacturer: IVECO FIAT SpA, Defence Vehicles Division, via Volta 6, I-39100 Bolzano, Italy.

Telephone: (0471) 905111 Telex: 400541 IVEDVD I Fax: (0471) 934240

MALAYSIA

MMC V-150 Commando Repower Kit

Development/Description

In response to a requirement issued by the Malaysian Ministry of Defence, MMC Engineering Services Sdn Bhd, a wholly owned subsidiary of the Malaysia Mining Corporation Berhad, developed a new powerpack for the Cadillac Gage V-150 Commando (4×4) multi-role vehicle which is used by the Malaysian Army.

This consists of a Cummins V-6-155 diesel engine coupled to a fully automatic Allison Transmission AT-545 transmission.

The first prototype was presented to the Malaysian Ministry of Defence in July 1987 and by early 1988 over 10 000 km of trials had been undertaken during which time it was demonstrated that not only were total life cycle costs reduced but also the operational range of the vehicle was increased to 800 km.

In June 1988, Alvis announced that it had entered into a formal joint venture agreement with MMC to use an Alvis upgrade package that it has designed and built for the Ferret scout car, for a potential Malaysian Army requirement. This upgrade package consists of a Perkins turbocharged 4-cylinder Phaser diesel engine coupled to a Chrysler A727 automatic transmission. The Ferret conversion has now been accepted by Malaysia and additional details are given under the United Kingdom.

Status: Development of the MMC V-150 Commando repower kit is complete, awaiting formal go ahead from the Malaysian Army.



Malaysian Army Cadillac Gage V-150 repowered by MMC Engineering Services (Christopher F Foss)

Manufacturer: MMC Engineering Services Sdn Bhd, 32nd Floor Menara PNB, 201A Jalan Tun Razak, PO Box 10936, 50730 Kuala Lumpur, Malaysia

Telephone: 2616000 Telex: MA 31316

NETHERLANDS

RDM AFV Retrofit Packages

Development/Description

Although RDM Defence Engineering is widely known for its upgrade packages for the 155 mm M114 and 105 mm M101 towed artillery systems (Jane's Armour and Artillery 1992/1993 pages 655/656), the company also carries out the overhaul and modernisation of tracked armoured vehicles for the home and export market.

One of the more recent contracts has been the modernisation and upgrade of the whole fleet of AMX series of light track armoured vehicles for Qatar. This contract was awarded late in 1991 with first upgraded vehicles being delivered early in 1993.

A total of 57 vehicles is being upgraded, 22 155 mm Mk F3 self-propelled guns, 33 members of the AMX VCI family including command post vehicles and ammunition resupply vehicles and two AMX-13 armoured recovery vehicles.

In addition to a complete overhaul, the vehicles are also having a new powerpack consisting of a Detroit Diesel Model 6V-53T developing 280 hp coupled to a Rockford fully automatic transmission.

The company is also overhauling 30 155 mm M109 self-propelled artillery systems of the Canadian Armed Forces and also installing a 5 hp auxiliary power unit.

Early in 1993 RDM was selected to overhaul 137 155 mm M1092 self-propelled howitzers of the Royal Netherlands Army between 1993 and 1996.

Status: Production as required.

Manufacturer: RDM BV General Engineering Department, PO Box 913, NL-3000 AX Rotterdam, Netherlands.

Telephone: (31 10) 487 2747 Telex: 20753 rdm nl

Fax: (31 10) 487 2299

POLAND

Zaklady Mecaniczne PZL - WOLA Diesel Engines

Development/Description

This company manufactures diesel engines for full tracked vehicles originally designed in the former Soviet Union but subsequently made under licence in Poland and often considerably improved.

Model S12-U APPLICATION TYPE

T-72 MBT 4-stroke, multi-fuel, water-cooled with direct fuel injection, supercharged CYLINDERS
RATED OUTPUT
MAX TORQUE AT
CRANKSHAFT SPEED
TOTAL PISTON
DISPLACEMENT
COMPRESSION RATIO
DRY ENGINE WEIGHT
LENGTH
WIDTH

HEIGHT

12, 60° V form 625 (574) kW at 2000 rpm

3360 (3090) Nm at 1300/1400 rpm

38.88 cu.dcm 14 980 kg 1480 mm 896 mm 902 mm

Note: Data in brackets relates to the earlier W46-6 engine where different

Model W55-U APPLICATION

TYPE

CYLINDERS RATED OUTPUT MAX TORQUE AT **CRANKSHAFT SPEED**

TOTAL PISTON

DISPLACEMENT COMPRESSION RATIO DRY ENGINE WEIGHT

LENGTH WIDTH HEIGHT

Model W-6B.AX

APPLICATION TYPE

CYLINDERS RATED OUTPUT MAX TORQUE AT

CRANKSHAFT SPEED TOTAL PISTON

DISPLACEMENT COMPRESSION RATIO

DRY ENGINE WEIGHT

T-55 and T-62 MBTs

4-stroke, diesel, water-cooled with direct fuel injection

12. 60° V form 456 kW at 2000 rpm

2400 Nm at 1200/1400 rpm

38.88 cu.dcm 930 kg

1584 mm 897 mm 896 mm

PT-76 light amphibious tank 4-stroke, water-cooled diesel with

direct fuel injection 6 in-line

176 kW at 1800 rpm

1100 Nm at 1050/1200 rpm

19.1 cu.dcm 850 kg

LENGTH 1412 mm 977 mm WIDTH HEIGHT 893 mm

Model A 650-G

Model 668 artillery tractor APPLICATION 4-stroke, water-cooled diesel with TYPE

direct fuel injection

CYLINDERS 12.60° V form RATED OUTPUT 220 kW at 1700 rpm MAX TORQUE AT

CRANKSHAFT SPEED 1520 Nm at 900/1000 rpm TOTAL PISTON

38.88 cu.dcm DISPLACEMENT COMPRESSION RATIO 15 DRY ENGINE WEIGHT 920 kg LENGTH 1732 mm WIDTH 897 mm HEIGHT 813 mm

Status: All of these engines are produced as required. In service with

Poland and other countries.

Manfacturer: Zaklady Mechaniczne PZL - WOLA, PL-00-961 Warsaw,

Poland.

Telephone: 36 84 45 Telex: 814751 zmin pl

Fax: 374513

PORTUGAL

BRAVIA AFV Retrofit Programs

The BRAVIA company has the technical ability to retrofit, repower and renovate the following armoured fighting vehicles using key subsystems supplied by Germany, the United Kingdom and the United States. For the heavier AFVs Detroit Diesel Corporation engines are used including the 6V-53T, 6V-92T, 8V-71T and 12V-71T and coupled to Allison Transmission fully automatic transmissions. Cooling systems are supplied by Airscrew while 90 mm and 105 mm guns are supplied by Rheinmetall and for some applications, missiles are supplied by Euromissile.

The company has also developed a repower package for its Chaimite family of 4 × 4 APCs which consists of a Detroit Diesel engine coupled to an Allison TX-200 automatic transmission

Modernisation packages are available for the following AFVs

USA Tanks - M4A3 Sherman, M5, M24, M41, M47 and M48

SPG - M42, M107, M108, M109 and M110 APC - half-tracks including M3A1 and M16, M113 into M113A1/M113A2/M113A3, M106A1, M125A1, M132A1, M577A1

Tanks - Chieftain, Centurion, Vickers Tanks - AMX-30 and AMX-13 France -Former USSR -Tanks- T-54/T-55, T-62, PT-76

APC - BTR-50, BMP Armoured cars - BRDM-2

China -Tank - Type 59

Status: Available.

Manufacturer: BRAVIA SA, Porto Alto, P-135 Samora Correia, Portugal,

Telephone: (063) 62256/62257 Telex: 12715 BRAVIA P

Fax: (1) 284-6293

SINGAPORE

Singapore Automotive Engineering

Singapore Automotive Engineering was established in 1971 as the automotive maintenance facility for military vehicles of the Singapore armed forces. Their activities cover a wide range of automotive engineering services, including rebuilding and modifications of military vehicles, tracked and wheeled and custom design of special purpose vehicles. The company also undertakes turnkey projects in the setting up of workshop and logistics systems relating to automotive maintenance.

Singapore Automotive Engineering has established four subsidiaries, Singapore Ordnance Engineering Pte Ltd (SOE), SAE Automotive Supplies Pte Ltd (SAS), SAE Inspection Services Pte Ltd (SIS) and Singapore Commuter Pte Ltd (SCL). The company is a member of the Singapore Technologies Holdings.

For many years Singapore Automotive Engineering overhauled AMX-13 light tanks of the Singapore armed forces and since 1988 has also been upgrading these vehicles.

More recently Singapore Automotive Engineering has developed a series of modernisation kits for upgrading and improving the AMX-13's automotive and hull systems.

SAE Retro-kit

This is a repowering kit based on the NATO-certified Detroit Diesel Model 6V-53T diesel engine developing 290 hp at 2800 rpm coupled to the ZF 5WG-180 power shift fully automatic transmission. This gives the vehicle greater speed, better acceleration and less fuel consumption. Maintenance is also reduced and the engine can be replaced using standard tools, in just 50 minutes

The fully automatic transmission has five forward and two reverse speeds and is controlled by an Electrical Control Unit (ECU) which is the brain of the powerpack and programmed to protect against unsafe shifts. In the case of an electrical failure there is a mechanical fallback.

The engine kit is also designed for coupling with the original manual transmission.

SAE Improved hull electrical system

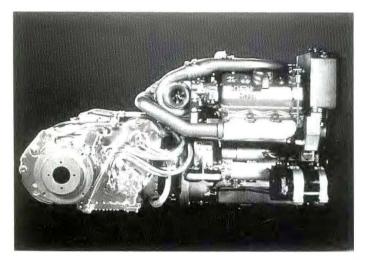
This is a totally new concept electrical system for upgrading the original system to modern day fighting vehicle standards. It is based on four 12 V batteries connected both in series and parallel so that if any single battery fails the others can still supply power. There is also a new 28 V 160 A fully suppressed alternator which is more reliable than the old dynamo system and is easier to maintain.

A new electrical slip ring has been fitted and a new ergonomically designed instrument panel has been installed for the driver. The electrical harness is to military standards and is sealed in shrinkable polyolesin tubing to protect it against oil, fuel and moisture. It is also heat resistant and is easy to maintain as it can be quickly disconnected and replaced for

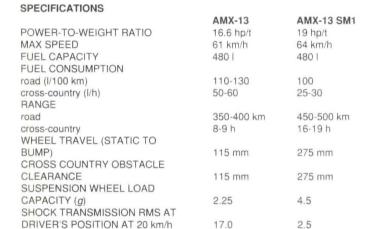
SAE Dunlostrut Suspension

This is a hydropneumatic suspension system for improved mobility and is described in more detail in the Suspensions section under Dunlop of the UK. The new suspension increases wheel travel and allows greater mobility

When upgraded with the above three modernisation packages the AMX-13 is designated the AMX-13 SM1.



Powerpack for the AMX-13 SM1 consists of the Detroit Diesel 6V-53T coupled to a ZF 5WG-180 automatic transmission



Upgrading of Cadillac Gage Textron V-100/V-150 and Chaimite

SAE offers the Detroit Diesel Corporation 8V 82T diesel engine coupled to an Allison Transmission AT-545 transmission and a new drive line.



AMX-13 SM1 upgraded by Singapore Automotive Engineering

Cadillac Gage Textron V-200

Many of these 4×4 APCs have been modified by Singapore and fitted with the Swedish Bofors RBS 70 surface-to-air missile system. A repowering kit has also been developed for this vehicle by SAE.

M113 series armoured personnel carrier

Various modifications have been carried out on these vehicles used by the Singapore armed forces including the installation of a 120 mm mortar, all electric turret system and other upgrading kits.

Other capabilities

These include the installation of fire-control systems in armoured fighting vehicles to improve their first round hit probability, rebuilding of components and assemblies and the design and development of maintenance facilities according to customers' requirements.

Manufacturer: Singapore Automotive Engineering Pte Ltd, 5 Portsdown Road, Singapore 0513.

Telephone: 4736311 Telex: SINENG RS 25755

Fax: 4710662

SPAIN

Placencia CD-850 Transmission Production

Description

In addition to manufacturing ammunition for the Swedish Bofors 40 mm L/70 towed anti-aircraft gun system used by the Spanish Army (qv Ammunition section) the Sociedad Anonima de Placencia de las Armas has manufactured components for the Spanish Army's AMX-30 MBTs.

It also manufactures assemblies and components for the Oerlikon-Contraves twin 35 mm anti-aircraft gun, 20 mm Oerlikon-Contraves light anti-aircraft gun and the OTO Melara 105 mm Model 56 Pack Howitzer.

More recently the company has started to manufacture, under licence from the United States, the Allison CD-850-6 series automatic transmission,

details of which are given later in this section under the United States of America.

After a pre-series of 20 CD-850-6A automatic transmissions built in Spain by late 1990 for installation in the upgraded AMX-30 MBTs of the Spanish Army, the company has supplied new transmissions and spare parts to the USA, Europe and the Far East. The CD-850-6A is also suitable for installation in modernised vehicles such as the former Soviet T-54/T-55 MBT.

Manufacturer: Sociedad Anonima de Placencia de las Armas, Apartado de correos no 8, E-20140 Andoain (Guipuzcoa), Spain.

Telephone: (43) 592011 Telex: 36176 SAPA E Fax: (43) 592703

UNITED KINGDOM

Alvis Scorpion Repower Package

Development/Description

Following extensive trials and evaluation, Alvis Limited now offers a diesel conversion package for all Scorpion CVR(T) tracked armoured vehicles.

According to Alvis, the engine, which is of proven design, allows for system compatibility and offers all of the financial, logistical, operational and technical advantages associated with diesel powered vehicles. This package provides the same effective system as that currently in service with a number of Alvis customers who initially selected the Perkins diesel

specification rather than the Jaguar petrol engine versions currently used by the British Army.

Diesel conversion packages can be undertaken in-country with the assistance of Alvis service engineers or at the company's facility in the UK and can also include training courses.

Main advantages of this conversion can be summarised as:

Reduced fuel consumption

Increased operational range

Increased life between overhauls

Reduced maintenance time and costs

Reduced fire hazard.



SPECIFICATIONS (ENGINE)

ENGINE TYPE NUMBER OF CYLINDERS BORE AND STROKE CAPACITY MAX POWER MAX TORQUE

Perkins turbocharged T6-3544 6 in-line 98.4 mm × 127 mm 5.81 150 kW (200 hp) at 2600 rpm 587 Nm at 1700 rpm

Status: Development complete. Ready for installation. New production CVR(T) vehicles, for example those built for Venezuela, have this fitted as

Manufacturer: Alvis Limited, The Triangle, Walsgrave, Coventry CV2 2SP.

Telephone: (0203) 535455 Telex: 31459 Fax: (0203) 539286

Perkins T6-3544 diesel being lowered into an Alvis Scorpion CVR(T) vehicle

Alvis Daimler Ferret Repower Package

Development/Description

As the vehicle design authority for the British MoD, Alvis is exclusively responsible for designing and proving any modification to the Ferret (4×4) scout car of which 4409 were built by Daimler between 1952 and 1971.

Alvis has ensured that the installation of the diesel package keeps modifications to a minimum while retaining existing subsystems wherever possible. Alvis has proved that this retrofit package will extend the vehicle life, increase operational efficiency, reduce life-cycle costs and maintain vehicle performance within safe limits.

The Alvis Ferret repower package consists of the in-production Perkins turbocharged Phaser 110 MT coupled to an A727 fully automatic transmission

The diesel conversion packages can be undertaken in-country with the assistance of Alvis service engineers or at the company's facility in the UK. If required they can also include training courses. Appropriate upgrades are also available from Alvis.

The main advantages of this repower package can be summarised as:

4 in-line vertical

100 mm × 127 mm

81 kW (109 hp) at 2800 rpm

354 Nm (261 lb/ft) at 1600 rpm

Perkins turbocharged Phaser 110 MT

Reduced fuel consumption

Increased operational range

Increased life between overhauls

Reduced maintenance time and costs

Reduced fire hazard.

SPECIFICATIONS

Engine

TYPE NUMBER OF CYLINDERS

BORE AND STROKE CAPACITY

CYCLE MAX POWER

MAX TORQUE

Transmission

TORQUE RATING 475 Nm (390 lb/ft)

TORQUE CONVERTER single stage, 3-element multi-phase type GEARS 3 forward, 1 reverse

41

4-stroke

Status: In production for Malaysia.

Manufacturer: Alvis Limited, The Triangle, Walsgrave, Coventry CV2 2SP,

Telephone: (0203) 535455 Telex: 31459 Fax: (0203) 539286



Daimler Ferret (4 × 4) scout car showing new Alvis repower package

Cummins AS90 Powerpack

Development/Description

The Cummins Engine Company of the UK offers diesel engines for military vehicle applications in the 50 to 660 bhp range. This power band is covered by the 3.9 litres B series 4-cylinder engine, the B and C 6-cylinder engines of 5.9 and 8.3 litres respectively and the VTA 903 14.8 litres V-8.

In addition to direct engine sales the company also contracts for powerpack supply and has total responsibility for the complete powerpack of the Vickers Shipbuilding and Engineering Limited AS90 155 mm self-propelled howitzer. This pack, branded MILPAC 660, comprises the Cummins VTA 903T-660 V-8 engine developing 660 bhp coupled to a German ZF LSG 2000 four-speed automatic transmission. First production AS90 155 mm self-propelled artillery systems were delivered to the British Army in 1992 by Vickers Shipbuilding and Engineering Limited

244 AFV ENGINES, TRANSMISSIONS AND POWERPACKS / UK

SPECIFICATIONS (MILPAC 660)

Engine

TYPE CUBIC CAPACITY MAX POWER MAX TORQUE

Transmission

TYPE DESIGN INPUT **GEAR SHIFT**

FORWARD GEARS REVERSE GEARS BRAKING SYSTEM STEERING

Cooling System

RADIATOR FAN DRIVE FANS EXHAUST SYSTEM SILENCER

Air Filtration

EXHAUST OUTLET PRIMARY STAGE

SECONDARY STAGE TERTIARY STAGE

Cummins VTA 903T-660 14.81

492 kW (660 bhp) at 2800 rpm

1930 Nm (1414 lb/ft) at 2000 rpm

ZF LSG 2000 crossdrive

torque converter with lock up automatic shift by nuclear-hard microprocessor with emergency manual override

integral hydrokinetic retarder compound, hydrostatic and

mechanical

two-pass fin and tube hydrostatic two, axial flow

insulated duct

direct into cooling fan efflux cyclonic with automatic dust evacuation

replaceable paper element

plenum chamber

Status: Cummins is currently supplying powerpacks and engines for the following military vehicle contracts:

VSEL 155 mm AS90 self-propelled howitzer for the British Army GKN Defence Saxon (4 × 4) APC for the British Army Leyland-DAF 4 tonne truck for UK MoD Seddon Atkinson 38 tonne for UK MoD

Sisu SA 240 (6 × 6) truck for Finnish Army

Telephone: 081 949 6171 Telex: 58643

Manufacturer: Cummins Engine Company Limited, 46-50 Coombe Road, New Malden, Surrey KT3 4QL, UK.



Complete powerpack for AS90 with LSG 2000 transmission on left and Cummins VTA 903T-660 engine on right

A F Budge (Sales) Retrofit Packages

Development/Description

Two UK companies, A F Budge (Sales) and Perkins Engines (Shrewsbury). have teamed to offer a variety of retrofit packages for tracked and wheeled vehicles, all of which utilise diesel engines produced by Perkins Engines. In addition to those for armoured fighting vehicles covered below, A F Budge (Sales) has also developed a repower package for the US M151 (4 \times 4) light vehicle

More recently further retrofit and repower packages have been studied for former Soviet vehicles including BTR series armoured personnel carriers and BRDM (4 × 4) reconnaissance vehicles.

T-54/T-55 Conversion

The consortium has developed a variety of retrofit packages for the T-54/T-55/T-62 manufactured by the former Soviet Union and the Chinese Type 59 vehicles.

The aim is to enable users to select from a variety of options which match operational and financial requirements.

Modules 1 and 2 of the retrofit package cover the engine and transmission. The new powerpack consists of the Perkins Engines (Shrewsbury) V-8 Condor engine (qv), developing 800 hp, coupled to an Allison XTG-411 (qv) fully automatic transmission. The latter has infinitely variable steering, and four forward and two reverse gears.

The engine and transmission are both proven systems already in

production for other applications. The Condor engine is mounted transversely in the hull, close-coupled to the XTG-411 transmission.

Using its experience in powerpack design, Perkins has packaged the IMI radiator and charge coolers, Serck oil coolers, twin Airscrew Howden mixed flow cooling fans and Donaldson pack-mounted air cleaner into a compact package suitable for the T-series tanks.

Hinged water radiators allow easy access to the transmission service points and to the final drives with the latter being fitted with quick disconnect couplings for rapid pack lift when required.

Modules 3 and 4 cover the suspension and running gear while modules 5 and 10 cover replacement of the existing 100 mm gun by a 105 mm weapon, laser rangefinder, improved gunner's sight, new stabilisation system and passive night vision equipment for the commander, gunner and driver.

Modules 11 to 13 include automatic fire detection/suspension system, add-on armour and the installation of smoke dischargers either side of the turret.

A F Budge (Sales) will either convert existing vehicles to the new configuration or offer vehicles brought up to the new standard.

Stalwart Upgrade

In addition to offering a retrofit package for the T-54/T-55/T-62 MBTs, the company has also developed to the prototype stage a retrofit package for the Stalwart (6 × 6) High Mobility Load Carrier.

The prototype of the upgraded Stalwart was completed early in 1990 and this has been trialled in the United Kingdom and Norway.

The original petrol engine is replaced by a more fuel-efficient Perkins Phaser 180 MTi diesel, improved clutch and a modern technology cooling system.



Powerpack for the upgraded T-55 MBT from A F Budge (Sales)



A F Budge (Sales) T-55 MBT fitted with new powerpack, 105 mm rifled gun and new day/night vision equipment



Saladin and Saracen diesel conversion vehicles after extensive proving trials in the Far East

The results of this are greatly improved reliability, reduced fuel consumption, increased operational range, improved maintenance and lower operating costs due to the use of proven commercial components.

Additional ergonomic improvements have been made to the vehicle including new driver's seat and revised instrument panel. The amphibious characteristics of the vehicle are retained.

AMX-30 MBT Conversion

This utilises the Perkins CV-8 Condor diesel engine rated at 804 hp (600 kW) coupled to an Allison XTG-411-5 fully automatic crossdrive transmission with torque converter and lock-up clutch controlled by ATEC. Total weight of this powerpack is 1085 kg.

Saladin/Saracen Conversion

This is essentially the same as that developed for the Alvis Stalwart High Mobility Load Carrier (6 \times 6) and by late 1992 one prototype of the Saladin

 (6×6) armoured car and one prototype of the Saracen (6×6) armoured personnel carrier had been completed and tested in the Far East. These conversions have been carried out in collaboration with Alvis Limited of Coventry who is the prime contractor.

M41 Light Tank

This is fitted with the Perkins CV-8 diesel engine and has undergone trials in the Far East.

Status: Development complete. Ready for production on receipt of orders.

Manufacturer: A F Budge (Sales), West Carr Road, Retford, Nottinghamshire DN22 7SW, UK.

Telephone: (0777) 708100 Telex: 56280 BUDGM-G Fax: (0777) 860122



M41 light tank repowered by A F Budge (Sales) during proving trials in the Far East

GKL FV600 Upgrades

Development/Description

In 1988 GKL announced that it was offering an enhancement package for the Alvis Saracen FV603 (6×6) APV under the designation of the Saracen 88.

GKL can offer vehicles upgraded to the new Saracen 88 configuration or supply kits to enable the user to upgrade vehicles to this configuration in their own workshops.

The Saracen 88 improvement package has a total of 23 improvements including the replacement of the original petrol engine by a more powerful and fuel efficient diesel engine, although the user can select only those improvements that meet his own specific requirements.

The upgrade package allows full combat load operation in ambient temperatures in excess of +45° with improved engine and gearbox cooling.

Other improvements include new AC vehicle electrics, new hydraulic power steering, new vehicle exterior and interior lighting, new dual braking air over hydraulic system, new vehicle electrical wiring and instrumentation, improved machine gun turret mount and new modern smoke grenade launchers.

A similar upgrade for the Alvis Saladin FV601 (6×6) armoured car is also offered by the company and this can include improvements to the turret system including the replacement of the 76 mm gun by a MECAR 90 mm weapon that can also fire APFSDS type ammunition.

The original petrol engine is replaced by a turbocharged diesel engine developing 250 hp at 2600 rpm coupled to a MT-600 fully automatic transmission with four forward and one reverse gears.

GKL also offer an upgrade package for the M151 (4 \times 4) light vehicle and the Alvis Ferret scout car. The latter is called the Harimau and has many improvements including a new powerpack consisting of a more fuel efficient VM HR 692 diesel developing 140 bhp at 3700 rpm coupled to a modified Jaguar 700 series preselective transmission with five forward and five reverse gears. The Harimau has permanent four-wheel drive with hub

reduction units at each wheel station and a non-slip differential can be provided if required. Full details of the Harimau are given in *Jane's Armour and Artillery 1992/93* page 255.

Status: Development complete. Conversion package ready for production on receipt of orders.

Manufacturer: GKL Equipment PTE Limited, Coworth Park House, Coworth Park, Ascot, Berkshire SL5 7SF, UK.

Telephone: (0344) 874202 Telex: 846062 GKLLDN G



Saracen 88 (6 \times 6) armoured personnel carrier upgraded by GKL Equipment PTE Limited

Horstman Defence Systems

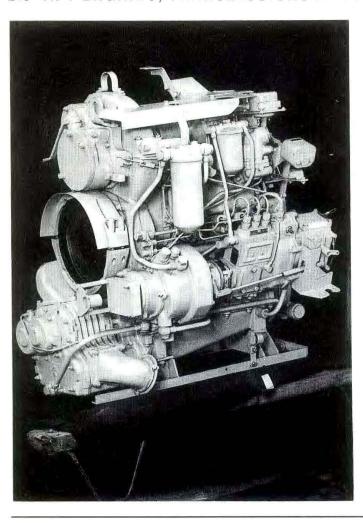
Development/Description

In addition to designing and manufacturing a wide range of suspension systems, details of which are given in the *Suspensions* section, Horstman Defence Systems are also involved in some elements of AFV powerpacks as well as gun control equipment. Details of the latter are given in the *Weapon control and stabilisation systems* section.

Transfer Gearbox for CET

Horstman Defence Systems manufactures the transfer gearbox for the Royal Ordnance Combat Engineer Tractor in service with the Indian and British armies. The gearbox provides the power take-off for the water-jets and hydraulic pumps.





H₃₀ Engine

The H30 is a 3-cylinder twin crankshaft opposed piston multi-fuel engine which is fitted to the Chieftain and Challenger 1 MBTs as their Auxiliary Power Unit (APU). The APU enables the MBT to run its turret systems, such as the air conditioning system, without running the main engine. The H30 was previously manufactured by Coventry Climax of Coventry. It is also installed in the British Aerospace (Dynamics) Tracked Rapier air defence system that is only used by the British Army.

FWMB Engine

The FWMB engine is available both as a diesel and a petrol engine, which is a four cylinder in-line overhead cam engine, and is used, in its petrol form, in the British Aerospace Towed Rapier air defence system.

Status: Production as required.

Manufacturer: Horstman Defence Systems Limited, Locksbrook Road,

Bath, Avon BA1 3EX, UK.

Telephone: (0225) 423111 Telex: 444363 Fax: (0225) 447357

H30 two stroke diesel engine used in the Chieftain and Challenger 1 MBTs and Tracked Rapier air defence system

Perkins 100 Series Diesel Engines

Description

Perkins 100 Series comprises a range of compact diesel engines with outputs from 4 to 33 kW (4 to 44 bhp) in 2, 3 and 4-cylinder configurations and capabilities from 0.4 to 1.9 litres. These compact, lightweight engines are ideally suited for both manportable and vehicle-mounted Auxiliary Power Units (APU's) powering electrical, hydraulic or air-conditioning systems.

Proven in military service, the 3-cylinder, 0.6 litre engine was selected by the British Army as the power supply for air-conditioning units in Challenger 1 during the Gulf Campaign and the 3-cylinder 0.9 litre model is currently supplied to Gallay Ltd, as an APU for the Egyptian Fahd (4×4) wheeled armoured vehicle. The 2-cylinder, 0.4 litre variant is under evaluation by the French Army Technical Centre, ETAS in Angers for future APU applications.

SPECIFICATIONS MODEL	102.04	103.09	103.12	103.15	104.19
OUTPUT (kW)	6.3	15.1	19.8	23.5	33
(bhp)	8.5	20.3	26.5	31.5	44
BORE/STROKE	64 mm/64 mm	72 mm/72 mm	82 mm/84 mm	84 mm/90 mm	84 mm/90 mm
NUMBER OF					4
CYLINDERS	2	3	3	3	4
CUBIC CAPACITY	411 cm ³	879 cm ³	1267 cm ³	1469 cm ³	1995 cm ³
CYCLE			4 stroke		
ASPIRATION			natural		
COMBUSTION					
SYSTEM			indirect injection		
COMPRESSION RATIO	24:1	23:1	22:1	22:1	19:1
GOVERNING			mechanical		
COOLING			liquid		
LENGTH	437 mm	527 mm	603 mm	613 mm	685 mm
WIDTH	362 mm	390 mm	462 mm	462 mm	455 mm
HEIGHT	519 mm	489 mm	636 mm	695 mm	676 mm
WEIGHT	71 kg	110 kg	149 kg	160 kg	202 kg

Status: Production.

Manufacturer: Perkins Engines (Shrewsbury) Limited, Lancaster Road. Shrewsbury, Shropshire SY1 4DP, UK.

Telephone: (0743) 212000 Telex: 35171/2 PESLG Fax: (0743) 212701



Perkins 103.12 compact diesel engine rated at 19.8 kW



Perkins 100 series powered APU driving air-conditioning system on Challenger 1 during Desert Storm

Perkins Phaser Diesel Engines

Development/Description

Representing the next generation of high-speed, water-cooled diesel engines, the Perkins Phaser has been designed to replace the successful Perkins T4.236 and T6.354 engines and spans the range of 80 to 157 kW (106 to 210 bhp) in 4-cylinder 4 litre and 6-cylinder 6 litre forms.

The Phaser family has been designed to operate over extended service intervals, typically 20 000 km between oil and filter changes and 100 000 km between valve tappet checks. Phaser incorporates state-of-the-art construction including deep skirted, computer optimised cylinder block design supporting silicon carbide honed dry cylinder liners, controlled expansion oil spray cooled pistons and forged molybdenum steel connecting rods and crankshaft.

The unique 'Quadram' combustion system eliminates high peak pressures and gives a cleaner burn helping to keep combustion noise to a minimum, reducing mechanical stress and giving enhanced reliability and durability together with cleaner emissions.

The Phaser 110T has been installed as a retrofit package in Malaysian Army Ferret scout cars and is in production versions of the Reynolds Boughton RB44 (4 \times 4) logistic truck now in service with the British Army. GKN has recently selected the 6-cylinder 210 Ti engine for their Simba vehicle, recently ordered by the Philippine Army.

Phaser retrofit packages have been developed and are approved for the Alvis FV600 family of vehicles including the Saracen armoured personnel carrier, Saladin armoured car and the Alvis Stalwart High Mobility Load Carrier.



4-cylinder Perkins Phaser diesel engine rated at 79 kW



Perkins Engines Phaser 110 T turbocharged diesel engine

SPECIFICATIONS			
MODEL	110T	180 Ti	210 Ti
OUTPUT (kW)	79	134	157
(bhp)	106	180	210
BORE/STROKE	100 mm/127 mm	100 mm/127 mm	100 mm/127 mm
NUMBER OF			
CYLINDERS	4	6	6
CUBIC CAPACITY	4.01	6.01	6.01
CYCLE	4-stroke	4-stroke	4-stroke
ASPIRATION	turbocharged	turbocharged	turbocharged
		intercooled	intercooled
COMBUSTION			
SYSTEM	direct	direct	direct
COMPRESSION			
RATIO	16:1	16:1	16:1
ROTATION	clockwis	se viewed from from	t
GOVERNING	mechanical		
COOLING		liquid	
LENGTH	711 mm	945 mm	945 mm
WIDTH	614 mm	673 mm	673 mm
HEIGHT	774 mm	854 mm	854 mm
WEIGHT	279 ka	419 ka	419 ka

Status: In production.

Manufacturer: Perkins Engines (Shrewsbury) Limited, Lancaster Road,

Shrewsbury, Shropshire SY1 4DP, UK

Telephone: (0743) 212000 Telex: 35171/2 PESLG Fax: (0743) 212701



6-cylinder Perkins Phaser diesel engine rated at 157 kW

Perkins T6.3544 Diesel Engine

Development/Description

The Perkins T6.3544 6-cylinder 5.89 litre engine was selected by Alvis as

the diesel engine replacement for the CVR(T) vehicle.

Rated at 150 kW (200 bhp), the T6.3544 gave the CVR(T) enhanced mobility, increased range through improved fuel economy and simplified logistics, common fuel and increased reliability. It was these qualities that led to this engine also being selected by Malaysia, Spain, Togo and Venezuela to power their brand new CVR(T) Scorpion vehicles

Rated at 186 kW (250 bhp), the T6.3544 is the selected engine for the Alvis Stormer family of vehicles currently in production for the Shorts Starstreak High Velocity Missile (HVM) system ordered by the British Army.

In naturally aspirated form the T6.3544 is used exclusively by the French truck manufacturer ACMAT for its large range of VLRA 4×4 , 6×6 and now 8 x 8 logistic vehicles. In addition to being used by the French Army they have also been exported in considerable numbers all over the world.

SPECIFICATIONS

MAX OUTPUT (kW) 186 250 (bhp)

BORE/STROKE 98.4 mm/127 mm NUMBER OF CYLINDERS 6

CUBIC CAPACITY 581 CYCLE 4-stroke

ASPIRATION turbocharged intercooled

COMBUSTION SYSTEM direct 16:1

COMPRESSION RATIO ROTATION clockwise viewed from front

GOVERNING mechanical COOLING liquid LENGTH 937 mm WIDTH 747 mm HEIGHT 864 mm WEIGHT 445 kg



Perkins T6.3544 six-cylinder turbocharged diesel engine from front

Status: In production. In service with Malaysia (Scorpion and Stormer), Spain (Scorpion), Togo (Scorpion), Venezuela (Scorpion) and the United Kingdom (Stormer).

Manufacturer: Perkins Engines (Shrewsbury) Limited, Lancaster Road, Shrewsbury, Shropshire SY1 4DP, UK.

Telephone: (0743) 212000 Telex: 35171/2 PESLG Fax: (0743) 212701

Perkins Eagle Tx Diesel Engine

Development/Description

The Perkins Eagle Tx is the latest development of the highly successful Eagle range of diesel engines developed in the mid-1970s.

Since that time, in various guises, the Eagle engine has been supplied to the British Army as its primary logistic vehicle engine powering vehicles such as Foden, Seddon Atkinson, ERF, Scammel (Unipower) and others with over 7000 engines in service.

Today it is in production rated at 350 hp as the 350e for installation in the Leyland DAF DROPS (8 × 6) vehicle and the new 400 Tx has been selected and is under trial in the new Unipower BR90 vehicle for the British Army.

As the C6 320 TF12 rated at 320 hp the Eagle powers the Royal Ordnance Combat Engineer Tractor (CET) which is used by India and the

Rated from 300 to 400 hp the Eagle Tx complies with Euro I emission regulations and can thus be retrofitted into older logistics vehicles.

According to Perkins, the worldwide migration of ex former Soviet equipment coupled to a lack of logistic vehicles may make vehicles such as the BMP-1 and BMP-2 ideal candidates for Eagle retrofit packages.

SPECIFICATIONS

MODEL MAX OUTPUT (kW) (bhp) BORE/STROKE NUMBER OF CYLINDERS CUBIC CAPACITY CYCLE **ASPIRATION**

COMBUSTION SYSTEM COMPRESSION RATIO ROTATION GOVERNING COOLING LENGTH WIDTH HEIGHT WEIGHT

EAGLE Tx

1030 kg

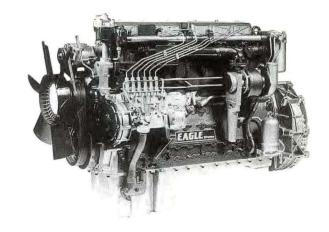
298 130.2 mm/152.4 mm 6 12.171 4-stroke turbocharged with air-to-air charge cooling direct injection 15.9:1 clockwise viewed from front mechanical liquid 1539 mm 716 mm 1070 mm

Status: Production.

Manufacturer: Perkins Engines (Shrewsbury) Limited, Lancaster Road,

Shrewsbury, Shropshire SY1 4DP, UK.

Telephone: 0743 212000 Telex: 35171/2 PESLG Fax: 0743 212701



The Perkins Eagle Tx diesel engine is compliant with Euro I emissions regulations

Perkins Condor Diesel Engines

Development/Description

The Perkins Condor family comprises the V8 and the V12 engines and was developed from the well established Eagle and 'C' range in-line 6-cylinder truck and industrial engines.

Innovative design features include unique slip fit 'dry liners' with oil backing. In the field no special tools are required to change these liners, thus allowing very fast turn around times. The extensive use of internal oilways has significantly reduced the number of parts, and potential leaks, making for a much more reliable and durable product in service.

Condor engines operate with either conventional mechanical flyweight governor, or with a full authority electronic Engine Management System (EMS). Highly responsive, EMS continuously monitors engine output and adjusts the control functions to optimise performance. In addition, the EMS controls the Inlet Manifold Heater (IMH), used on some higher rated low compression versions of Condor, during initial cold starts and light load running. IMH gives excellent startability, even down to $-35/-40\,^{\circ}$ C, with the minimum of black smoke emission.

Condor V8 rated at 410 kW (550 bhp) powers the Warrior IFV vehicle, used extensively during Desert Storm with the British Army, and in 1992/3 saw service with the NATO forces in Bosnia. It has also been selected, after competition, by the Kuwait armed forces. In Warrior the engine is coupled to the Perkins X300-4B crossdrive transmission (see later section on transmissions) manufactured at Perkins Shrewsbury. This combination gives the vehicle excellent mobility in the harshest of terrain with maximum power to the tracks under all conditions. The cooling package ensures that the vehicle will perform at its best even with ambient temperature above 50°C.

A development of CV8 recently exhibited at the EuroSatory Exhibition features in the LP³ powerpack for 'T' Series and AMX-30 retrofits. Rated at 600 kW (800 bhp) at 2300 rpm, it represents the only true retrofit package according to the manufacturer that fits in the 'T' Series chassis without major hull modifications. The air cleaner is pack-mounted, hence under armour, and the cooling group is designed to cool maximum power in a 50°C ambient, ensuring the vehicle consistently performs at its best.

In LP3 the bulk volume of the engine is no larger than that for the 410 kW engine as used in the Warrior, and easily meets the 1000 hp/l m3 benchmark

demanded for future armoured fighting vehicles. Integration of dry sump lubrication has enabled an overall engine height reduction of below 900 mm. Other features include a gear driven three stage oil pump and engine driven, oil spray cooled generator.

In 1991, as part of the evaluation programme for the retrofit of the French Army AMX-30 medium tanks the Condor V8 rated at 550 kW (740 bhp) successfully completed a 400 hour NATO type test at the ETAS test facility in Angers. Running at 2400 rpm to match existing transmission requirements, the engine demonstrated its complete versatility of operation, for a range of vehicle applications.

Currently developing 100 bhp/cylinder, the structural design of the CV8 will allow outputs of 150 bhp/cylinder or more. With the application of integrated subsystems, Electronic Unit Injectors (EUI), EMS with diagnostics, prognostics BIT and BITE, and advanced air management systems, much higher ratings could be achievable in the near future. EUI allows much greater flexibility of fuel management, for example higher injection pressures, variable injection timing whilst running and even cylinder cycling whilst idling. This could help reduce fuel consumption, hence improve Brake Thermal Efficiency, lower smoke and emissions levels and control combustion pressure rise thereby reducing total noise.

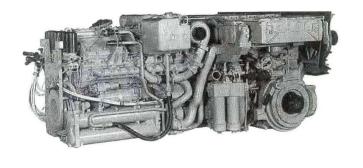
The Condor V12 engine rated at 895 kW (1200 bhp) powers both Challenger 1 and Challenger 2 MBTs. At the same rating it is also the prime mover for the Challenger Armoured Repair and Recovery Vehicle (CRARRV). During Desert Storm the CRARRV achieved a remarkable availability of 100 per cent; Challenger 1 itself achieved a very creditable 98 per cent, with both vehicles averaging some 100 km per day during the entire campaign.

The Scammell (now Unipower) Commander, which uses the Condor V12 rated at 470 kW (625 bhp), completed a total of around 2.5 million km, an average of 260 km per day per vehicle for the entire campaign.

Recently, the V12 engine has been evaluated by the US Army Tank Automatic Command (TACOM), rated at both 895 kW and 1120 kW (1500 bhp). At 1120 kW the engine completed performance testing in excess of 300 hours assessing altitude capability, fuel tolerance, temperature tolerance and so on. Reports concluded that, 'From the performance, fuel economy, power density and multi-fuel points of view this engine was very attractive for application in the M1 and similar vehicles'. The evaluation was carried out as part of the Military Assessment of Commercial Items (MACI) programme.



Powerpack for Warrior IFV comprising Perkins Condor 8V-550 TCA engine coupled to a Perkins built X-300-4B transmission



Powerpack for the Challenger 2 and CRARRV comprises the Perkins Condor V12-1200 TCA engine and the David Brown Vehicles Transmissions TN54 transmission

250 AFV ENGINES, TRANSMISSIONS AND POWERPACKS / UK

Perkins own ongoing programmes in the field of Armoured Fighting Vehicles involves installation studies and prototypes builds to assess the suitability of Condor for retrofit opportunities in such vehicles as M1 Abrams and AMX Leclerc, both at 1500 bhp, Chieftain and Centurion at 750, 900 and 1000 bhp, 'T' Series and AMX-30 at 800 bhp, Vijayanta at 750 bhp, AMX-30 at 740 bhp and M41 at 475 bhp.

SPECIFICATIONS

APPLICATIONS

MODEL V8-800 4-stroke, direct injection. compression ignition CONFIGURATION CONSTRUCTION Thin wall SG cast iron crankcase and cylinder head CYLINDER DETAILS 135 mm bore stroke 152 mm liners slip fit dry type valves 4 valves/cylinder; twin camshafts one/cylinder bank SWEPT VOLUME 17.411 COMPRESSION RATIO 13.5:1 FUEL SYSTEM pressurised; feeds into injection pump gallery and manifold air heater. Remote-mounted electronic governor regulates fuel supply to suit engine demands COOLING liquid (water); thermostatically controlled centrifugal pump. Airscrew Howden hydraulic mixed cooling fan LUBRICATION SYSTEM dry sump; 3 tier gear-driven oil pump: 2 filters ASPIRATION twin single-stage turbochargers with air-to-air charge cooling RATING max power 600 kW (800 bhp) at 2300 rpm max torque 2750 Nm at 1575 rpm **BSFC** 222 g/kWh (0.365 lb/bhp/h) at 2300 rpm 200 g/kWh (0.329 lb/bhp/h) at 1800 rpm LENGTH 1030 mm WIDTH 1050 mm HEIGHT 901 mm WEIGHT 1292 kg dry wet with radiators. coolant and charge air coolers 1782 kg

MODEL TYPE

CONFIGURATION CONSTRUCTION

CYLINDER DIMENSIONS SWEPT VOLUME COMPRESSION RATIO FUEL SYSTEM

ASPIRATION

COOLING SYSTEM

LUBRICATING SYSTEM

ELECTRICAL SYSTEM

STARTERS

RATING max power max torque BMEP BSFC

LENGTH WIDTH HEIGHT WEIGHT drv

wet, with radiators coolant and chargeair coolers APPLICATIONS V12-1200A

compression ignition 60° V-12 major components of SG cast iron, cylinder head of SG iron as for V8-800A 26.11 I 12.3:1

4-stroke, direct injection,

electrically controlled jerk-type monobloc fuel pump with hydraulically operated injectors twin single-stage turbochargers, pressure lubricated, rear-mounted with air-to-air charge cooling water-cooled by rear-mounted gear driven centrifugal pump with thermstatically controlled flow dry sump, 3 tier gear oil pump (2 scavenge, 1 pressure) with 4 filters

24 V; alternator up to customer requirements twin 24 V electric. An induction manifold heater burner is incorporated to aid cold starting

895 kW (1200 bhp) at 2300 rpm 4126 Nm (3043 lb ft) at 1700 rpm 1783 kPa (258 psi) 220 g/kWh (0.361 lb/bhp/h) at 2300 rpm 208 g/kWh (0.342 lb/bhp/h) at 1700 rpm 1459 mm 1270 mm 1182 mm

1888 kg

2638 kg Challenger 1 MBT; Challenger Armoured Repair and Recovery Vehicle, Challenger Training Tank, Challenger 2 MBT, Khalid (with TN37 transmission); reengined Chieftain MBT, Vickers Mk 3 (I) (TCE

developing 850 bhp), Vickers Mk 3 MBT and Indian Vijayanta MBT (V12-750)

Status: In production. In service with the British Army and ordered by a number of other armed forces including Kuwait (Desert Warrior) and Oman (Challenger 2 and Challenger Armoured Repair and Recovery Vehicle).

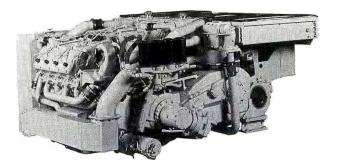
410 kW (550 bhp) version

installed in Warrior infantry

Fighting vehicle

Manufacturer: Perkins Engines (Shrewsbury) Limited, Lancaster Road, Shrewsbury, Shropshire SY1 4DP, UK.

Telephone: (0743) 212000 Telex: 35171/2 PESLG Fax: (0743) 212701



Perkins Low-Profile Powerpack (LP3) comprises the Condor V8-800 TCA engine with the Allison XTG-411-5 transverse transmission

Development/Description

Based on a long successful involvement with the design and manufacture of armoured vehicle powerpacks including programmes which produced Chieftain, Warrior, Challenger and M41, today Perkins offers a complete package under the tradename of PowerpaK Systems + Plus. This comprises: PowerpaK covering engine, EMS, transmission and cooling groups

Systems covering electrics, hydraulics, generators, auxiliary drives, air cleaners and exhaust systems

+ Plus covering complete Logistic Support including design and production, spares, tools, test equipment, training and communications.

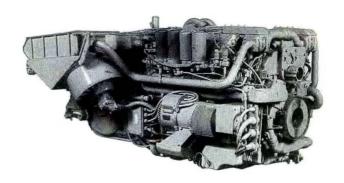
A résumé of the engine/transmission combinations being offered under the PowerpaK Systems + Plus is listed below:

Transmission	Allison	David Brown	General Electric	Renk	Self- Changing	SESM	ZF	Perkins
Engine type/bhp			(USA)		Gears			
Condor V12 1500	*			*				
Condor V12 1200	*						*	
Condor V12 1000	*							
Condor V12 900				÷			•	
Condor V12 800	*	•						
Condor V12 750				•	*		*	
Condor V8 1000	*	•			*		*	
Condor V8 800	*		*	*	*			
Condor V8 650		*	*	*		*		
Condor V8 600			*			*		*
Condor V8 550	*							
Condor V8 475								
TV8 640 350							*	
TV8 540 250					*			*
Phaser 300 MTi								
Phaser 210 MTi								

Status: Development/production as required.

Manufacturer: Perkins Engines (Shrewsbury) Limited, Lancaster Road, Shrewsbury, Shropshire SY1 4DP, UK.

Telephone: (0743) 212000 Telex: 35171/2 PESLG Fax: (0743) 212701



Powerpack for M41/M44 retrofit comprising Perkins Condor V8-475T coupled to original CD-500 transmission

New David Brown Transmissions

Development/Description

David Brown Vehicle Transmissions sees two main paths for the future: first, further development of the type of system fitted in the TN54 transmission (qv) but using newer technology and second, layshaft type transmissions such as the P40 (qv).

It would be possible to develop a very compact and efficient transmission for use in the modern fighting vehicle. A twin-layshaft transmission, the

TN56, has been supplied to the Royal Armament Research and Development Establishment for development trials.

Status: Development.

Manufacturer: David Brown Vehicle Transmissions Limited, Park Road,

Huddersfield HD4 5DD, UK.

Telephone: (0484) 422180 Fax: (0484) 435292

David Brown TN54 Transmission

Development

This fully automatic transmission has been developed under contract to the UK Ministry of Defence, to be interchangeable with the TN37 transmission installed in the Challenger 1 MBT. The TN54 is now in production for the Challenger Armoured Repair and Recovery Vehicle, the six forward gears giving the tractive performance to meet the arduous demands of this role and for the Challenger 2 MBT.

Description

The TN54 has a single input and two in-line outputs at right angles to the input. Drive is transmitted from the engine through a splined coupling to a torque converter. The gear and direction of travel are engaged by correctly

sequenced application of multi-plate clutches, actuated hydraulically and controlled by electrosolenoid valves. The TN54 transmission features six forward and two reverse gears, a hydrostatic double-differential steering system and integral oil-cooled multi-plate main vehicle and parking brakes.

The transmission has integral filtered lubrication and hydraulic systems. A power take-off for powerpack cooling fans is mounted on top of the main casing.

Alternatively the transmission is supplied with a mechanical steer unit incorporating controlled slip multi-plate clutches.

TN54 is also available to suit transversely mounted engines and in this designation it is known as the TN54U.

SPECIFICATIONS

GEARS 1st forward 7.174:1 2nd forward 4.87:1 3rd forward 3.26:1 4th forward 2.207:1 1.498:1 5th forward 1.003:1 6th forward 1st reverse 5.015:1 2nd reverse 1.544:1

RATING 1120 kW (1500 bhp) gross at

2300 rpm

MAX TORQUE 5100 Nm (3750 lb ft) at 1800 rpm

LENGTH 1169 mm

WIDTH 1734 mm (inc couplings) HEIGHT 1012 mm (inc PTO)

WEIGHT (dry) 2390 kg

Status: In production for Challenger Armoured Repair and Recovery Vehicle and Challenger 2 MBT.

Manufacturer: David Brown Vehicle Transmissions Limited, Park Road.

Huddersfield HD4 5DD, UK.

Telephone: (0484) 422180 Fax: (0484) 435292



David Brown TN54 fully automatic transmission

David Brown TN37 Transmission

Development

This fully automatic transmission has been developed under contract to the UK Ministry of Defence by David Brown and is installed in the Challenger 1 MBT in service with the British Army and in Khalid tanks used by Jordan. More recently it has been fitted to the Challenger Training Tanks. Over 1000 TN37 transmissions have been built.

Description

The TN37 has a single input and two in-line outputs at right angles to the input. Drive is transmitted from the engine through a splined coupling to a



David Brown TN37 automatic transmission as installed in Challenger 1 MBT

torque converter. The gear and direction of travel are engaged by correctly sequenced application of multi-plate clutches, actuated by electrosolenoid valves. It has four forward and three reverse gears and the steering module is of the hydrostatic double differential regenerative type.

Automatic control is by means of an electronic control unit operating hydraulic clutches through electrosolenoid valves. The transmission has integral filtered lubrication and hydraulic systems. Main vehicle brakes are of the integral oil-immersed multi-plate type. A PTO for the powerpack cooling fans is mounted on top of the main casing.

Alternatively the transmission is supplied with a mechanical steer unit incorporating controlled slip multi-plate clutches.

SPECIFICATIONS

 GEARS

 1st forward
 4.201:1

 2nd forward
 2.547:1

 3rd forward
 1.654:1

 4th forward
 1.003:1

 1st reverse
 3.922:1

 2nd reverse
 2.547:1

 3rd reverse
 1.544:1

RATING 895 kW (1200 bhp) gross at 2300

rpm

MAX TORQUE 4140 Nm (3055 lb ft) at 1650 rpm

(BSS)

LENGTH 1169 mm

WIDTH 1734 mm (inc couplings) HEIGHT 1012 mm (inc PTO)

WEIGHT (dry) 2335 kg

Status: In production for Challenger 1 and Khalid MBTs and Challenger Training Tank.

Manufacturer: David Brown Vehicle Transmissions Limited, Park Road, Huddersfield HD4 5DD, UK.

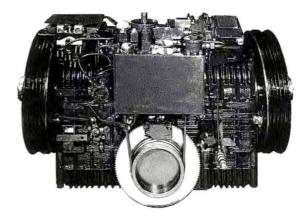
Telephone: (0484) 422180 Fax: (0484) 435292

David Brown P40 Transmission

Development/Description

The P40 semi-automatic transmission is derived from the David Brown Z51 transmission fitted to the Centurion MBT, of which over 4000 were produced and many remain in service today.

The P40 concept is available either as a retrofit package to existing Z51 transmissions or as new. The transmission is a layshaft type with five forward and two reverse gears. There is a single input and two in-line outputs at right angles to the input. Gearshifts are initiated by driver command and effected by an electronic controller. The controller operates electrosolenoid valves to hydraulic actuators which engage dog clutches under conditions of synchronous speed. Steering is of the triple-differential type effected by the operation of either of the transmission-mounted vehicle drum brakes. The transmission has an integral filtered lubrication system. Cooling is by convection and radiation through the gearcase, alternatively by a small separate oil cooler.



David Brown P40 transmission

SPECIFICATIONS

GEARS	
1st forward	11.643:1
2nd forward	4.593:1
3rd forward	2.855:1
4th forward	1.807:1
5th forward	1.343:1
low reverse	22.894:1
high reverse	3.859:1
DATING	ECO LIM /ZEO bal

RATING 560 kW (750 hp) at 2500 rpm

MAX TORQUE 2060 Nm

LENGTH	788 mm
WIDTH	1329 mm
HEIGHT	822 mm
WEIGHT (dry)	1016 kg

Status: Ready to enter production on receipt of orders. Has been trialled in a Swedish Army Centurion MBT.

Manufacturer: David Brown Vehicle Transmissions Limited, Park Road,

Huddersfield HD4 5DD, UK.

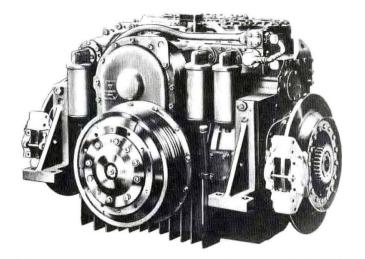
Telephone: (0484) 422180 Fax: (0484) 435292

SCG TN12 Transmission

Development/Description

The TN12 transmission was originally designed by Self-Changing Gears Limited for the Chieftain MBT but development has extended the range to include designs capable of input powers in excess of 1000 hp in both remote or close coupled configurations. TN12 series transmissions have been installed in Chieftain, Vickers Mk 1, Mk 3 and Mk 3(I), Vickers Valiant, Chieftain 900 and all incorporate epicyclic geartrains in the change speed section to give six forward and two reverse speeds. Vehicle steering is achieved by a fully regenerative Merritt-Wilson triple differential system which maintains power through turns and provides an axis steer capability for high manoeuvrability.

By eliminating unnecessary clutches, all TN12 units feature high mechanical efficiency, giving higher sprocket power for a given gross



 $SCG\ TN12\ series\ crossdrive\ automatic\ transmission\ as\ installed\ in\ Chieftain\ and\ Vickers\ MBTs.$

engine power. In addition, a corresponding reduction of burden on, and therefore size of, cooling group can often be achieved. Designs of intermediate versions between TN12 and TN12-1000 exist for both new vehicles and matching to replacement engines in existing TN12 installations such as Vijayanta and Chieftain MBTs.

The latest generation of this range, denoted T-1200, utilises the TN12-1000 core to which is applied the latest electronics and materials technology to control, steer and start modules - giving an optimum match to today's high torque rise turbocharged engines.

SPECIFICATIONS TN12 Model TN12-1000 **GEARS** 1st ratio/optional 14.68/11.16 12.4 2nd ratio/optional 8.47/6.44 7.08 3rd ratio/optional 5.23/3.98 4.35 4th ratio/optional 3.34/2.54 2.82 5th ratio/optional 2.25/1.71 1.89 6th ratio/optional 1.52/1.16 1.28 reverse/optional 9.83/7.47 7.93 reverse/optional 6.57/5.00 5.32 WEIGHT 1270 kg 1361 kg LENGTH 925 mm 925 mm WIDTH 1247 mm 1273 mm HEIGHT 876 mm 876 mm MAX INPUT TORQUE 2509 Nm at 3660 Nm at 1500 rpm 1600 rpm MAX INPUT POWER 522 kW at 785 kW at 2500 rpm 2300 rpm

Status: Production. By early 1993 production of the TN12 transmission amounted to over 5000 units with production continuing. It is installed in Vickers Mk 1 and Mk 3 MBTs, all Chieftain MBTs and variants. It has also been installed in the Vickers Mk 3(I) MBT which is still at the prototype stage and was installed in the Vickers Valiant and Chieftain 900 private venture MBTs which are no longer being marketed.

Manufacturer: Self-Changing Gears Limited, Lythalls Lane, Coventry, West Midlands CV6 6FY, UK.

Telephone: (0203) 688881 Telex: 31644 SELCHA Fax: (0203) 666660

TN15

SCG TN15 Transmission

Development/Description

The TN15 transmission was developed by Self-Changing Gears for the Alvis Scorpion CVR(T) family of tracked vehicles. Over 3500 units have been completed. The basic TN15 is a crossdrive transmission matched to 149 kW (200 hp) petrol engines. The TN15 HD has been designed for diesel engines with a similar 149 kW (200 hp) output and is for the Alvis Scorpion and Stormer vehicles. The new T300 is a high performance 224 kW (300 hp) transmission conceptually identical to the TN15 but is a new design using uprated components throughout.

The TN15 range of automatic crossdrive transmissions has been designed for independent mounting with drive transmitted through a resilient input coupling into a centrifugal clutch.

Planetary or epicyclic geartrains are used in the change speed sections to give seven ratios, with the transmission being fully bi-directional. Vehicle steering is achieved by the use of an integral Merritt-Wilson triple differential system. The two transmission outputs to the vehicle final drives are mounted at right angles to the transmission input.

SPECIFICATIONS Model

model	11410
GEARS	
1st ratio/HD	28.65/16.1
2nd ratio/HD	12.77/7.18
3rd ratio/HD	9.17/5.15
4th ratio/HD	5.51/3.1
5th ratio/HD	3.05/1.72
6th ratio/HD	2.32/1.31
7th ratio/HD	1.47/0.83
WEIGHT	425 kg
LENGTH	626.72 mm
WIDTH	890.7 mm
HEIGHT	572.7 mm
MAX INPUT TORQUE	358 Nm at 2500 rpm
	(petrol) or 530 Nm
	at 2000 rpm (diesel)
MAX INPUT POWER	153 kW at
	5000 rpm
	(petrol) or 145 kW
	at 2800 rpm (diesel)

254 AFV ENGINES, TRANSMISSIONS AND POWERPACKS / UK

Status: TN15 is installed in all members of Scorpion CVR(T) family. By January 1993 over 3500 TN15 transmissions had been completed

Manufacturer: Self-Changing Gears Limited, Lythalls Lane, Coventry,

West Midlands CV6 6FY, UK.

Telephone: (0203) 688881 Telex: 31644 SELCHA Fax: (0203) 666660



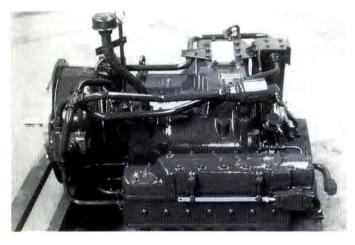
SCG TN15 transmission as installed in CVR(T) Scorpion family

SCG TN26 Transmission

Development/Description

The TN26 transmission was developed by Self-Changing Gears specifically for the Royal Ordnance Combat Engineer Tractor in service with the British and Indian armies. It is a specialist in-line unit with torque converter coupling and four ratios in both forward and reverse. The directional selections give a high ratio, high output speed operation for road running and a low ratio, high torque operation for working operations such as bulldozing and digging. In the road running selection the torque converter is locked out in third and fourth gears by a hydraulically actuated clutch.

The torque converter is a three element unit of Self-Changing Gears design with a stall torque ratio of 3.1 to 1 and a diameter of 330 mm. The unit is driven from the engine via a step-up transfer box giving a maximum speed to the converter of 3550 rpm.



SCG TN26 transmission as fitted in Combat Engineer Tractor

The transmission is manually operated using selector switches for selection of the ratio gears and direction change. The unit can be fully automatic.

In the event of vehicle electrical system failure or malfunction, two manual override gears can be achieved by mechanical actuation of the hydraulic valves. The ratios selected are forward and second, for example high second, or reverse and third, for example low third. Selection is by means of a lever on the hydraulic valve block housing.

The transmission output is taken to a separate steer unit. In the particular vehicle for which TN26 was designed, controlled differential steer is used for road driving and skid steer for most effective bulldozing and similar work.

SPECIFICATIONS

2

3

CONFIGURATION in-line 4-speed fully automatic or manual transmission **SPEEDS** 4 forward, 4 reverse

INPUT lock up torque converter, with freewheel.

3.10:1 stall torque ratio MAX INPUT TORQUE 472 lb ft at 2850 rpm MAX INPUT POWER 300 bhp at 3550 rpm RATIOS forward reverse 3.52 7.53

2.22 4.75 3.25 1.53 1.00 2.14 OVERALL RATIO SPREAD 10.91

CONTROL SYSTEM electrohydraulic fully automatic or

manual WEIGHT 571.5 kg

Status: In production. Installed in Royal Ordnance Combat Engineer Tractor (CET) in service with India and the UK. By early 1993 over 200 TN26 transmissions had been completed.

Manufacturer: Self-Changing Gears Limited, Lythalls Lane, Coventry,

West Midlands CV6 6FY, UK

Telephone: (0203) 688881 Telex: 31644 Fax: (0203) 666660

SCG T300 and T320 Transmission

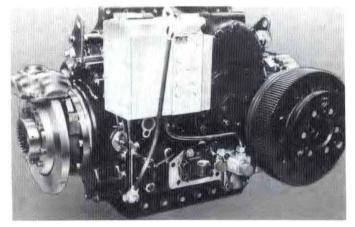
Development/Description

Development of T300 series units is easily traced back to the TN15 transmission developed by SCG for the Alvis Scorpion family of tracked vehicles, and which is still in production.

T300 transmissions are conceptually identical to TN15, but are of a new design using uprated components throughout, with the latest T320 type designed for vehicles weighing around 20 tonnes and engines of 350 bhp. T300 is currently installed in the Alvis Stormer range of vehicles and in the Korean Infantry Fighting Vehicle. T320 units are fitted in a heavier version of the Korean IFV and units have also been incorporated in retrofitted versions of the AMX-13 and M113 ranges. The latter include Self-Changing Gears own M113 Technology Demonstrator (qv).

T300 series units are automatic crossdrive transmissions, which can be mounted independently or close-coupled to the engine. Drive is transmitted from the engine through a resilient input coupling to a centrifugal clutch. Epicyclic (planetary) geartrains are used in the change speed section and the transmission is fully bi-directional. Vehicle steering is by use of an integral Merritt-Wilson triple differential system and the two transmission outputs to the vehicle final drives are mounted at right angles to the transmission input.

The T320 automatic control system comprises an electrohydraulic valve



Self-Changing Gears T320 transmission

CDECIFIC ATIONS

block which receives and interprets signals from the microprocessor control panel. The control panel in turn interfaces with the system peripherals which either provide condition data or actuate a subsystem to supplement the automatic operation. Signals are received by the control panel from an electromagnetic speed sensor, a microswitch on the throttle linkage indicating coast or drive conditions and the driver's gear selector. Signals are transmitted from the panel to the electrohydraulic valve block and a solenoid on the engine fuel pump which acts as a throttle dip mechanism.

The driver's gear selector has seven positions for engine start and tow starting modes, emergency low gear and two operating modes with gear hold overrides.

Oil pressure for hydraulic control and lubrication is supplied by an inputdriven gear type pump. Pressure for gear engagement during tow starting is provided by a piston type plunger pump driven from the left hand steering annulus.

The directional gears comprise a cluster of spiral bevel pinions in constant mesh with an input bevel gear. The direction of rotation can be changed by engaging a dog clutch with either of the pinions.

The engine drives a resilient input coupling, which minimises engine torsionals, into a centrifugal clutch. This provides an automatic method of creating a break between the engine and transmission.

The gearbox section consists of a three-speed compound epicyclic gearset connected to a low/high range splitter unit giving six speeds. Low range is obtained by use of an epicyclic train and high range by a multiplate clutch.

The proven Merritt-Wilson triple differential steering system ensures power is maintained through turns and provides a full axis turn capability. It comprises a central differential, a pair of output epicyclic geartrains and acts as a split path transmission. Drive is taken from the differential carrier into the gearbox section of the transmission and from there to the annuli of the output epicyclic geartrains. Drive is also taken through the differential to

each of the sunwheels of the output geartrains. A hydraulically operated disc brake is connected to each sunwheel. Vehicle sprocket drive is taken from the planet carrier of each output epicyclic geartrain.

SPECIFICATIONS		
Model	T300	T320
GEARS		
1st ratio	14.11	14.35
2nd ratio	6.13	6.22
3rd ratio	4.39	4.16
4th ratio	2.61	2.63
5th ratio	1.44	1.48
6th ratio	1.09	1.07
7th ratio	0.69	
LENGTH	616 mm	1076 mm
WIDTH	993 mm	654 mm
HEIGHT	572 mm	658 mm
WEIGHT	477 kg	574 kg
MAX TORQUE	840 Nm at 1800 rpm	980 Nm at 1800 rpm
MAX INPUT POWER	202 kW at 2400 rpm	260 kW at 2800 rpm

Status: T300 in production. Installed in Alvis Stormer and Korean IFV. T320 in production. Installed in heavier versions of Korean IFV and retrofitted in AMX-13 and M113 variants. By January 1993 over 1150 T300 and 20 pre-production T320 units had been completed.

Manufacturers: T300: Manufactured under licence in UK and South Korea. T320: Self-Changing Gears Limited, Lythalls Lane, Coventry, West Midlands CV6 6FY, UK.

Telephone: (0203) 688881 Telex: 31644 SELCHA Fax: (0203) 666660

Self-Changing Gears M113 Technology Demonstrator

Development/Description

The M113 Technology Demonstrator consists of an M113 APC rebuilt by Marshall of Cambridge (Engineering) Limited with a new powerpack consisting of the Cummins Engine Company 6 CTA 8.3 diesel coupled to a Self-Changing Gears T320 fully-automatic transmission. Equipment has also been supplied by Lucas CAV and AP Precision Hydraulics. To improve the vehicle's cross-country mobility Horstman Defence Systems dampers have been installed on the first and last road wheel stations either side.

The Cummins 6 CTA engine is offered at capacities of up to 310 hp allowing the recommended power-to-weight ratio of 25 hp/tonne to be available up to 12.4 tonnes gross vehicle weight.

The complete retrofit package gives the M113 increased power and acceleration, improved manoeuvrability, greater speed on gradients, improved braking performance, improved driver control as the original sticks are replaced by a steering wheel, and improved cross-country mobility.

The T320 transmission replaces the original Cletrac unit and offers fully regenerative steer enabling power and speed to be maintained throughout turns and with axis turns achieved in neutral. There is a separate entry on the T320 transmission in this section.

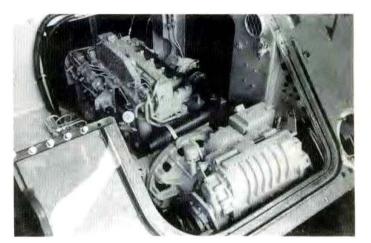
Gear changing is fully automatic with provision for driver override and the driving console has been redesigned. This is now adjustable for head out and closed down operations and also includes improved throttle and ramp lever controls.

The power hydraulic brakes on the retrofit demonstrator meet EEC regulations and are controlled by a foot pedal. A fail safe spring brake is used for parking and acts on the same 406 mm disc.

The Cummins 6 CTA 8.3 diesel and T320 transmission are close coupled using a diaphragm plate between the engine flywheel and the transmission centrifugal clutch.

A subframe is bolted to the four conventional mounts to provide a single engine location point to the hull. Two new trunnion mounts at the transmission outputs give the powerpack a conventional three-point fixing.

The original cooling system has been retained but with hydraulic actuation of the fan for ease of operation.



Close-up of Cummins 6 CTA 8.3 diesel and Self-Changing Gears T320 fully automatic transmission in M113 series APC

The standard telescopic dampers have been replaced by new Horstman rotary damper units to give increased performance in both bump and rebound modes, enabling full advantage to be taken of the vehicle's increased power, especially in cross-country operations.

The M113 technology demonstrator has a maximum speed of 70 km/h and performance comparison with the M113A1 predicts a 40 per cent reduction in the 0 to 30 km/h time. Gradients of 60 per cent can be taken in top gear and 40 per cent in fifth gear and even with a gross vehicle weight of 13.6 tonnes the vehicle can achieve a 60 per cent gradient restart capability.

Status: Prototype. In 1989 the vehicle was demonstrated in Turkey fitted with a Cadillac Gage one-man turret by local specialists Hema Hidrolik AS.

Manufacturer: Self-Changing Gears Limited, Lythalls Lane, Coventry, West Midlands CV6 6FY, UK.

Telephone: (0203) 688881 Telex: 31644 Fax: (0203) 666660

UNITED STATES OF AMERICA

United States Electric Drive Developments

Development/Description

In late 1992 it was revealed that a joint research project involving TARDEC, FMC Corporation and General Dynamics, Land Systems Division, was underway to develop an electric propulsion system technology demonstrator that could eventually lead to all electric combat vehicles.

In such a system the main vehicle engine, which could be a diesel or gas turbine, would drive an electric generator which in turn would supply power

through electric cables to the track sprocket drive motors and all other vehicle electrical and electronic equipment.

With an electric drive system there would be no complex transmission as the driver would make power changes needed to alter speed by a single control that changes the voltage and current to the drive motors.

In June 1992, TARDEC awarded separate research contracts to FMC and General Dynamics, Land Systems Division, to conduct a technology

survey and develop competing electric drive concepts for tracked vehicles in the 18 ton (US) and 30 ton (US) classes over a 12-month period. TARDEC would then have the option to select one proposal for further development and seek approval to extend the contract for a period of a further four years.

The selected company would then build a 30-ton (US) capacity electric propulsion system and install this in a test vehicle which would be called the Electric Drive Technology Demonstrator (EDTD).

The EDTD will utilise a M1 MBT chassis as this has plenty of space for other equipment used in trials programmes.

A vehicle electric propulsion system may have the potential to improve the vehicle's combat effectiveness by making it possible to replace the standard chemical propellant fired gun with an electric type gun (qv AFV Armament section).

Status: Development project. Not yet in service.

Advanced Integrated Propulsion System

In August 1982 the United States Army Tank Automotive Command awarded study contracts to six contractors to study Advanced Integrated Propulsion Systems (AIPS) for future MBTs. The study, which was completed in 1983, evaluated various engine/transmission combinations, filtration systems, auxiliary power units and NBC protection systems.

Late in 1984 the Cummins Engine Company and General Electric Company were each awarded contracts for the second phase of AIPS. During this phase each contractor built a complete powerpack consisting of engine, transmission, filtration system, auxiliary power unit and an NBC system. Cummins used a diesel engine, General Electric a gas turbine.

Allison Transmission has supplied each contractor with a new transmission system. The contracts, covering engineering, research, development and prototype construction, are worth \$76 million.

Under the terms of the original contract, each contractor has delivered a complete AIPS to TACOM to demonstrate a 50-hour mission profile plus cooling system testing.

According to Tank Automotive Command, the objective of AIPS is to demonstrate advanced technologies in a completely integrated propulsion system to provide opportunities for major advancements in space claim, performance, fuel economy and life-cycle cost. The principal goals of AIPS are, as compared to the AGT 1500 power pack of the M1/M1A1/M1A2: 50 per cent reduction in size, up to 50 per cent reduction in fuel consumption and 50 per cent lower life-cycle costs.

General Electric

The General Electric is called the LV100 and has a goal of producing a powerpack with a 50 per cent reduction in volume, the space saved could be used for ammunition or fuel or to reduce the size of the vehicle.

The LV100 is expected to achieve a 50 per cent reduction in operating and support costs compared to current powerplants, this being achieved by built-in maintenance features, improved component reliability and built-in test equipment with diagnostic and prognostic messages to identify and recommend actions to correct faults.

The control system is an integrated digital electronic system for the complete powerpack incorporating the diagnostic/prognostic equipment that eliminates separate field test equipment.

The improved gas turbine cycle efficiency and improved system efficiency in the integrated powerpack will provide an increase in vehicle range compared to current systems as well as eliminating the need for an auxiliary propulsion unit.

A self-clearing inlet filtration system senses loading of the barrier filters, triggering a pulse jet system to back-flush filters while the vehicle is moving. The gasifier combustor uses long-life aircraft engine technology. Simple fuel injectors are air-cooled during combustion and are purged free of fuel after shutdown to prevent coking of fuel in hot areas.

The cooling system is designed to meet requirements for downhill braking on a 15 per cent slope which results in generous margin at the normal .7 gross vehicle weight tractive effort point. For improved fuel economy, the integrated control will modulate cooling fan speed to match system loads.

Members of the General Electric LV100 team are RCA for digital electronic control, MTU for the recuperator, LP turbine and powerpack integration, Donaldson for air filtration, Allison Transmission for transmission and with General Electric responsible for the overall system and gas generator. More recently Textron Lycoming has joined the team and is now a partner with GE Aircraft Engines.

General Electric's new LV100 GP-1A core engine ran for the first time in the Autumn of 1987 and was followed by initial tests that established the compatibility of the engine components, mapped compressor performance, and assessed flows, pressures and stresses throughout the engine, versus pre-test predictions.

By late 1988 all LV100 AIPS components, including the full engine, transmission and cooling system were on test. In early 1989 the engine/transmission was tested with full powerpack, with assembled inlet filtration and pack cooling later in 1989.

In July 1989 a combined engine/transmission was tested, this being the first time they ran together; this surpassed the minimum 750 sprocket horsepower requirement established by the US Army.

The 200 hour equivalent inlet ingestion test was also completed successfully, so demonstrating the required levels of pressure drop, engine protection and the self-cleaning capability of the Donaldson air filter system.

Cummins AIPS

The Cummins AIPS, known as the XAP-1000, consists of a new V-12 engine, transmission, final drives, cooling systems, air and filtration systems and electronic fuel injection system.

As the prime contractor for the diesel AIPS, Cummins has enlisted the services of Allison, Donaldson, AirResearch and Cummins subsidiaries Holset, Cummins Electronics, Atlas and Electronic

The main advantages of the Cummins AIPS relative to the current M1 powerpack are a 45 per cent reduction in powerpack volume, increased durability and reliability, a 50 per cent improvement in fuel economy, minimal support requirements and reduced lifetime operating costs.

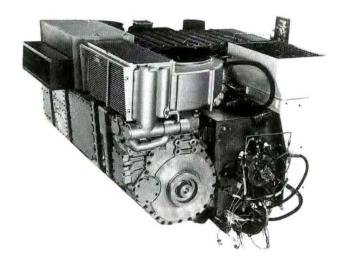
Technical innovations encompassed in the Cummins AIPS include the elimination of the conventional water-cooling system, the use of ceramics to reduce overall heat rejection to the engine oil, advanced variable geometry turbo-machinery and electronics that control engine operation as well as providing onboard diagnostics/prognostics. Other innovations include advanced air and liquid filtration systems which extend maintenance intervals and minimise support costs.

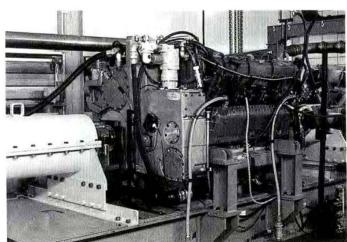
The Cummins AIPS was chosen for the Component Advanced Technology Test Bed (CATTB) and Cummins delivered a complete AIPS which was installed in the CATTB (based on a modified M1A1 MBT chassis) late in 1992.

Contractors

Attention: Government Business Mailcode 60622, Cummins Engine Company Inc, Columbus, Indiana 47202-3005, USA.

General Electric Company, Mail Drop 37405, 1000 Western Avenue, Lynn, Massachusetts, USA.





Cummins XAP-1000 Advanced Integrated Powerpack on specially constructed test rig at Cummins Technical Centre

Textron Lycoming AGT 1500 Gas Turbine

Development/Description

The M1 MBT was the first production ground combat vehicle to rely solely on a gas turbine for its motive power. The AGT 1500 design was offered to the US Army in the early 1960s as the powerplant for the MBT-70 project, with an Army development contract being awarded in 1965. In 1973 the engine was selected by Chrysler as the powerplant for its entry in the XM1 MBT programme and validation tests on the installed engine were conducted at Aberdeen and Yuma Proving Grounds. These tests were completed in 1976 and the XM1 contract was awarded to Chrysler's tank with the AGT 1500 engine in preference to the General Motors' design which used the Teledyne AVCR-1360. Full-scale engineering tests were conducted from 1976 to 1979 when the Army initiated production of the XM1 tank and the AGT 1500 engine. Extensive Army tests with first year production tanks in all environments and at various locations were completed in 1981.

In the normal driving range the special features of the turbine engine, notably the recuperator and variable power turbine nozzles, reduce fuel consumption below that of a conventional turbo-shaft engine to approach an equivalent power diesel engine. Moreover, the turbine has a wider fuel tolerance, being able to run on most automotive grades of fuel from gasoline to marine diesel oil as well as aviation fuel.

Among other advantages of the gas turbine are the virtual absence of visible smoke, the relatively low noise and vibration levels and the improved accessibility to the engine as a result of its lower volume.

The first production engine was delivered in November 1979. More than 360 engines were delivered by the end of 1981. A 30 per month production rate was achieved by mid-1981, by 1982 production was running at 60 per month; 90 per month being reached late in 1983.

For the past seven years production of engines, spare engines and engine equivalent models has averaged 100 a month. In March 1987 Textron Lycoming was awarded a \$1.4 billion multi-year procurement contract for the AGT 1500 by the US Army which called for the delivery of 3299 engines plus spare engines and a combination of spare modules.

This multi-year procurement contract was completed in January 1991.

At the conclusion of the multi-year contract in January 1991, Textron Lycoming signed a Long-Term Contract (LTC) with the US Army. This contract includes sales of 1053 engines, plus spare engines and spare modules, with additional options in 1994. This contract runs through 1994.

A modified AGT 1500 engine, with provisions for supplying bleed air for the M1A1 (formerly M1E1) tank NBC system, was introduced into production in limited quantities in May 1985 and was in full production by November 1985.

The AGT 1500 will continue to be the primary engine for the upgraded M1A2, the first production model of which was handed over to the US Army late in 1992.

Variants

Since the M1 MBT was first introduced some 10 years ago, the weight of the vehicle has increased while the power of the AGT 1500 engine has remained constant at 1500 hp.

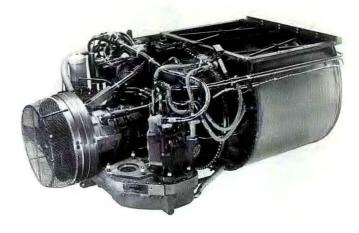
In 1991 the company proposed a Performance Recovery Programme (PRP) for the AGT 1500 which will not only restore the vehicle's performance characteristics but will also give a 40 per cent better fuel efficiency during training and 15 per cent better efficiency during battlefield day conditions. It will also enable silent watch with full turret capabilities, reduce the maintenance task of cleaning the air filters and extend the engine's life.

The average engine power of the AGT 1500 will be increased by 175 hp. This will be achieved by increasing the power turbine speed by 20 per cent and improving the high pressure turbine efficiency. A two-stage reduction gearbox will enable the transmission to see the same input speed as before

A 75 hp under armour Combat Support Module (CSM) will be incorporated. This consists of an auxiliary power unit, exhaust duct and an air inlet. It will be mounted as a fifth module on the AGT 1500 and is connected to the engine accessory gearbox through a two-way clutch and uses main engine oil, fuel and filter oil.

When used in lieu of idling the main engine, the CSM provides a 60 per cent improvement in fuel efficiency under equivalent load, allowing thermal sights, laser rangefinder, turret drives and NBC system to be used without the main engine operating.

The current V-pack static inlet air filters are replaced by a new drop-in self-cleaning air filter module providing a significant improvement in the



Textron Lycoming AGT 1500 gas turbine

maintenance level required between cleaning or changing the filter packs. This uses existing technology from the company's involvement in the AIPS and TMEPS projects.

Late in 1986, General Dynamics Land Systems Division, as prime contractor, was awarded a contract to build and demonstrate a transverse-mounted engine propulsion system for the M1 MBT, with Textron Lycoming and Allison Transmission being the main subcontractors. The contract culminated in 1990 with the transverse powerpack being installed in an M1 tank for field trials.

This propulsion system will employ an advanced AGT 1500 gas turbine engine developing 1550 hp, and will be mounted transversely and aft against the transmission saving 75 cu ft of the propulsion space in the vehicle.

SPECIFICATIONS

TYPE gas turbine with recuperator and free turbine

FUEL SYSTEM full authority electronic control of fuel handling system twin spool axial/centrifugal

compressor; 2-stage air cleaner TURBINE INLET

TEMPERATURE 1193°C (2180°F) RATING 1125 kW (1500 shp) at 30 000 rpm

SFC 300 g/kWh (0.493 lb/shp/h) at 1125 kW;

289 g/kWh (0.475 lb/shp/h) at 900 kW

FUELS DF-1, DF-2, DF-A, JP-4, JP-5, JP-8; gasoline

JP-4, JP-5, JP-8; gasoline and marine diesel in emergency

APPLICATION M1, M1A1 and M1A2 MBTs, installed in Leopard 2

for trials

for trials

Status: Production. By early 1993 over 11 000 AGT 1500 engines had been built for the M1 series of MBT used, or ordered by Egypt (M1A1), Kuwait (M1A2), Saudi Arabia (M1A2) and the United States (M1/M1A1/M1A2).

Manufacturer: Textron Lycoming, 550 Main Street, Stratford, Connecticut 06497, USA.

Telephone: (203) 385 2753 Telex: 964242 Fax: (203) 385 3255

Cummins Diesel Engines

Development/Description

The name Cummins was traditionally associated with heavy duty truck engines until recently, when the Cummins VTA 903-T500 engine was selected to power the US Army's M2 IFV and M3 CFV, production commencing in 1981. In 1991 Cummins started delivering the VTA-903-T600 for upgraded versions of the Bradley Fighting Vehicle and by early 1993 had delivered some 10 500 engines for this programme with production continuing for both home and export.

The V-903-T295 engine is used to power the MBY M9 ACE which entered production for the US Army in 1987.

The VTA-903-T660 is used to power the Vickers Shipbuilding & Engineering AS90 155 mm self-propelled howitzer, selected by the British Army in mid-1989 as the Abbot replacement. This engine is part of a complete powerpack designed and supplied by Cummins Engine Company Limited. Deliveries of powerpacks (MILPAC/660) started in 1991. There is a separate entry for the MILPAC/660 powerpack under the United Kingdom.

The VTA-903-T is also a candidate for armoured vehicle retrofit. The US Marine Corps AAVP7, which was originally fitted with the 8V-53T diesel engine was refitted with the Cummins VT-903-T400 engine. New production of the AAVP7A1 since 1982 has been with the VT-903-T400 engine.

The VTA-903-T has been employed in retrofit of M41 light tanks, including the M41s of the Danish Army.

AFV ENGINES, TRANSMISSIONS AND POWERPACKS / USA

Cummins diesel power ranges from 50 to 2000 hp in eight basic engine series and are available in naturally aspirated, turbocharged and aftercooled models.

R series

In-line 4 and 6-cylinders with displacements of 3.9 and 5.9 litres and with outputs of 50 to 250 hp (37 to 187 kW).

C series

In-line 6-cylinder with a displacement of 8.3 litres and with outputs of 150 to 310 hp (112 to 231 kW). The advanced C series engine uses a modern unitary construction for ease of maintenance and repairability. Heavy duty components include a massively strong steel crank with hardened fillets and large bearing areas for strength and durability. The latest C series power ratings are 224 kW (300 bhp) and 261 kW (350 bhp)

N14 series

In-line 6-cylinder with a displacement of 10 litres and with outputs of 250 to 500 hp (186.43 to 372.85 kW).



Cummins C series diesel engine

Status: Production.

V903 series

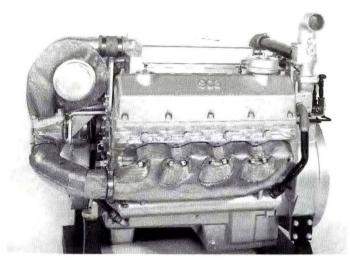
90° V8-cylinder with a displacement of 14.8 litres and with outputs of 265 to 660 hp (198 to 492 kW). Since the engine was introduced evolutionary changes have included a larger camshaft, air-to-air after-cooling and increased cylinder pressures allowing horsepowers to rise to the current 447 kW (600 bhp) and 491 kW (660 bhp) and the soon to be introduced twin turbo 558 kW (750 bhp) rating.

V28 series

60° V12-cylinder engine with a displacement of 28 litres and with outputs of 545 to 900 hp (406 to 672 kW). (These are used mainly in military generator sets and marine craft).

K series

In-line 6-cylinder, V12 and 16-cylinder with displacements of 19, 38 and 50 litres and with outputs of 450 to 2000 hp (336 to 1491 kW).



Cummins VTA 903T V-8 diesel engine which powers Bradley and Fighting

Manufacturer: Cummins Engine Company Inc, Columbus, Indiana 47202,

Telephone: (812) 377 3921 Telex: 217410 CUMMINS CMB A

SPECIFICATIONS Model

TYPE

CONFIGURATION CYLINDER

DIMENSIONS bore stroke SWEPT VOLUME

ASPIRATION COOLING SYSTEM

VTA 903-T600 (Big Cam)

4-stroke, compression ignition

90° V-8

140 mm 121 mm 14.81

single turbocharger

liquid (there is also an air-cooling fan on front right of engine in FVS Carrier); belt-driven pump with thermostatically controlled bypass

RATING

max power max torque **BSFC**

493 kW (660 bhp) at 2800 rpm 1526 Nm (1200 lb ft) at 2000 rpm 252 g/kWh (0.414 lb/bhp/h) at 1400 rpm 225 g/kWh (0.37 lb/bhp/h) at 2100 rpm 240 g/kWh (0.345 lb/bhp/h) at 2600 rpm

LENGTH 1148 mm WIDTH 1011 mm HEIGHT 1288 mm WEIGHT (dry) 1190 kg **APPLICATIONS**

M2 IFV: M3 CFV: M993 MLRS Carrier: M987 FVS Carrier: 155 mm AS90 (see earlier entry); M41; light tank (Danish Army, see entry under Denmark

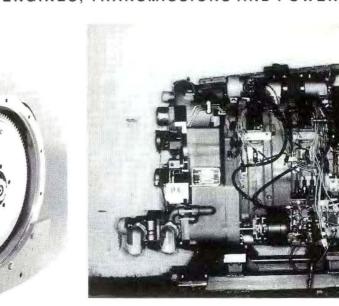
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Rotary Power International Stratified Charge Omnivorous Rotary Engine (SCORE)

Development/Description

Rotary Power International Inc (RPI) acquired all of the rotary engine assets of John Deere Technologies International Inc (JDTI) on December 31, 1991. RPI is in the process of developing three families of Stratified Charge Omnivorous Rotary Engines (SCORE): the 70, 170 and 580 series. A fourth series, the 40 Series, has recently been added. These numbers identify the rounded value of displacement in centilitres/rotor; for example the 580 Series engines have a displacement of 5.78 litres/rotor which is rounded to 5.8 litres/rotor or 580 centilitres (580 Series family). At full development each of these engines families are projected to consist of models ranging from single rotor units up to 4 or 6 rotor engines. The individual SCORE model designations consist of a 4 digit number. The first digit denotes the number of rotors in the engine, and the next three digits denote displacement in decilitres. The letter R is appended to designate that the identification is for a rotary engine. For example, the 2116R model is a twin rotor member of the 580 Series family, with a total displacement of 11.6 litres (rounded).

The design configuration for all of the 70, 170 and 580 families of SCORE engines now under development feature aluminium housings, cast iron rotors and forged steel crankshafts, for light overall weight. The inside surfaces of the housings are provided with a ground and lapped hard coating for durability and wear resistance. Another common feature of these 3 families of SCORE engines is that all engines are direct injected, spark ignited, turbocharged and intercooled, and their fuel systems feature dual injectors: a pilot and main injector. A spark plug (or glow plug) ignites the pilot fuel, which is injected ahead of the main charge, forming a rich mixture which serves as an 'ignition kernel'. Main charge is directed toward this ignition kernel, ensuring smooth and complete combustion. It is this patented injection/ignition system concept that enables SCORE engines to run in virtually any liquid fuel (to date without any adjustments required either to the fuel injection system or the ignition system), and that gives these engines their 'Omnivorous' capabilities. SCORE engines are the only



SCORE Rotary Engine Series 70 Model 2023R

rotary engines developed to date capable of operating on virtually any liquid fuel without the use of starting aids to -25°F.

The 2 rotor Model 2116R and the 3 rotor Model 3174R of the 580 Series are nearing completion of a Family of Engines Demonstration and Validation (D&V) programme under a contract sponsored by the United States Marine Corps (USMC). The rated power and speed for this application is 560 kW (750 bhp) at 3600 rpm for the twin rotor model 2116R and 840 kW (1125 bhp) at 3600 rpm for the 3 rotor model 3174R. Over 10 000 hours of testing has been accumulated to date. Both of these models are currently undergoing mission profile and endurance tests to the NATO cycle as a last part of the D&V contractual requirements. A contract modification has been received to explore an increase in power from 375 bhp/rotor to 500 bhp/rotor with an additional 10 per cent margin. An additional modification has been received to conduct reliability testing of the Model 2116R rated at 750 bhp to demonstrate its Mean Time Between Failures threshold value.

The next phase of this programme will consist of Demonstration and Validation of the 2 rotor 580 Series engine rated at 746 kW (1000 bhp) and the 3 rotor engine rated at 1120 kW (1500 bhp). These engines are candidate engines for the Advanced Amphibious Assault Vehicle for the Marine Corps. Prototype engines can be made available for installation and evaluation in 1993/1994. The 2013R (twin rotor 70 Series) is a prime candidate for lightweight engine generator sets. The engine is also being considered as the propulsion power source for small Navy combatant craft and remote controlled submersibles. A pilot production run has been made on this SCORE rotary engine.

SCORE Rotary Engine Series 580 Model 2116R

The initial power and speed rating of these 3 SCORE engine families will be:

70 Series - 75 kW (100 bhp)/rotor at 6000 rpm 170 Series - 150 kW (200 bhp)/rotor at 4800 rpm 580 Series - 280 kW (375 bhp)/rotor at 3600 rpm

Several models of the 580 and 70 Series family are currently under development for applications in armoured fighting vehicles, and auxiliary power/mobile electric power systems, respectively.

RPI acquired the assets of Defense Group Industries Inc (DGII), of Farmingdale, LI, NY on August 14, 1992. Included within these assets is intellectual property on gasoline, gaseous fuel and heavy fuel 300 and 400 cc Wankel-type engines, both naturally aspirated and turbocharged. Further, RPI signed an exclusive North American licence on October 20, 1992 with Wankel GmbH of Lindau, Germany for their small Wankel-type gasoline, gaseous fuel and heavy fuel engines. This acquisition and licence adds the 40 Series family of engines to RPI's family of rotary engines under development. The 40 Series in its diesel fuelled version offers an unprecedented prime mover in size and weight for military APUs, PPUs, ECUs, UAVs and UUVs.

The initial power and speed ratings of the 40 Series engine family will be: Diesel fuelled naturally aspirated 11-13 kW (15-18 bhp)/rotor at 3000 and 3600 rpm, respectively

Diesel fuelled turbocharged 26-37 kW (35-50 bhp)/rotor at 4000 and 6000 rpm, respectively

Specifications for the 2116R, 3174R, 2013R, 1004R naturally aspirated and turbocharged are shown in the table.

SPECIFIATIONS					
MODEL	2116R	3174R	2013R	1004R	1004R
TYPE	SCORE*580	SCORE*580	SCORE*70	LOCR***	LOCR***
CONFIGURATION	Twin Rotor	Three Rotor	Twin Rotor	Single Rotor	Single Rotor
ASPIRATION	TCI	TCI	TCI	NA	TCI .
DISPLACEMENT					
litres (cu in)	11.56 (705.5)	17.34 (1058.3)	1.32 (80.8)	0.41 (24.4)	0.41 (24.4)
COOLING SYSTEM	water/glycol	water/glycol	water/glycol	water/glycol	water/glycol
RATING	560 kW (750 hp)	840 kW (1125 hp)	150 kW (200 hp)	11-13 kW (15-18 hp)	26-37 kW (35-50 hp)
	at 3600 rpm	at 3600 rpm	at 6000 rpm	at 3300-3600 rpm	at 4000-6000 rpm
LENGTH	1107 mm	1349 mm	633 mm	305 mm	445 mm
WIDTH	1044 mm	1120 mm	744 mm	318 mm	318 mm
HEIGHT	925 mm	925 mm	546 mm	343 mm	343 mm
WEIGHT (dry)	822 kg**	1134 kg**	147 kg	32 kg	34 kg
FUELS	any liquid	any liquid	any liquid	Diesel and JP	Diesel and JP
	fuel	fuel	fuel		

amphibious assault vehicles; fighting vehicles; heavy tactical vehicles; combatant craft propulsion; marine power generation small craft propulsion; light-weight engine-generator sets; auxiliary and mobile power generation auxiliary power units; environmental control units; prime power units; unmanned aerial vehicles; unmanned underwater vehicles; land robotic vehicles

NOTES:

POTENTIAL APPLICATIONS

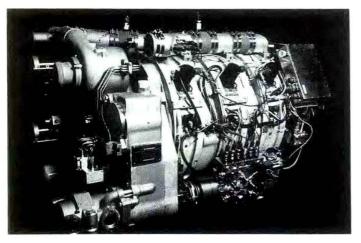
*SCORE - Stratified Charge Omnivorous Rotary Engine

TCI - Turbocharged and intercooled

*Includes sump and internal oil cooler

***Liquid cooled housings and oil cooled rotor

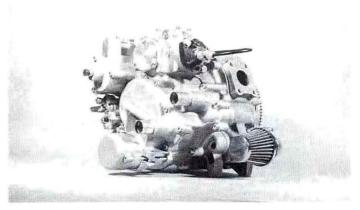
Status: Development.



SCORE Rotary Engine Series 580 Model 3174R

Manufacturer: Rotary Power International Inc, 22 Passaic Street, PO Box 128, Wood-Ridge, NJ 07075-0128, USA.

Telephone: 201 470 7002 Fax: 201 777 2516



SCORE Rotary Engine Series 40 Model 1004R

Detroit Diesel Corporation Engines

Development/Description

Detroit Diesel Corporation is a joint venture of General Motors and the Penske Corporation which was formerly part of the Detroit Diesel, Allison Division of General Motors.

The company is a manufacturer of a diversified line of heavy-duty two and four cycle diesel engines ranging from 50 to 2400 horsepower for use in powering trucks, combat vehicles, boats and ground support equipment.

Through a 1988 Marketing Agreement between Detroit Diesel Corporation and Perkins Engine Group, Detroit Diesel now offers Perkins engines to the North American market in the range of 5 to 1200 horsepower.

The North American military market has utilised the Series 500 engine for MB4 tow tractors, fork lift trucks, de-icers and marine applications. The Condor V12 currently rated at 1200 hp has potential growth to 1500 hp in anticipation of the US Army Heavy Forces Modernisation Program.

Series 53 engine

These engines have gained worldwide acceptance in military applications requiring reliability, durability and maintainability in a range of 50 to 350 horsepower.

The 3-53 (100 hp) engine is used extensively in SD-2 aircraft spotting dollies with the 4-53 powering US Air Force MJ-1 aircraft hydraulic test stands and US Navy P-16 onboard fire-fighting vehicles.

The 6V-53 (210 hp) powers the widely used M113A1 and M113A2 family which has evolved into the 6V-53T (275 hp), powering the upgraded M730 Chaparral and M113A3 vehicles. The US Marines LAV (8 \times 8) is also powered with the 275 hp version.

Foreign manufacturers have also selected the 6V-53T to power their vehicles including MOWAG Piranha, ENGESA Cascavel and Urutu armoured vehicles including FMC Corporation's co-production programmes for new M113A2 vehicles in Pakistan and AIFV vehicles in Turkey.

Repower of M113, A1 and A2 and AMX-13 vehicles in a number of countries has utilised the engine at horsepower levels from 265 hp to

275 hp with several countries having tested vehicles up to 350 hp. The 6V-53T is NATO certified to 300 hp and is currently undergoing testing for certification to 350 hp. This version will include after-cooling and a glow plug system for unaided starting to -25°F . The glow plug system can be adopted by any existing 6V-53 military engine.

Series 71 and 92

Built on the same proven design principle, the Series designation refers to cubic engine displacement/cylinder - 71 and 92 cu in respectively. Models include naturally aspirated, turbocharged and after-cooled engines from 4 to 16 cylinders with ratings from approximately 100 to 1450 hp.

The 8V-71T engine is widely used in self-propelled artillery powering the M107, M109 and M110 and the related M578 armoured recovery vehicle.

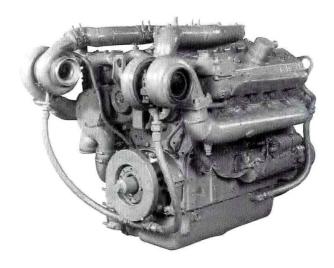
The 12V-71T has been chosen to power the Vickers Defence Systems Mk 3 MBT and its specialised variants, and is also offered in various retrofit packages for the M47 and M48 MBTs.

Detroit Diesel is currently utilising a Low Heat Rejection cylinder head for M109A6 Paladin and associated FAASV engines which use heat shields cast into the head air passages ultimately reducing the engine's heat rejection to coolant. This allows for moderate horsepower growth which was previously limited by the marginal cooling system of the M109. Glow plugs were also incorporated into the head allowing the engine to be cold started at –25°F in less than one minute. This technology will be adopted in other higher horsepower engine programmes.

The 6V-92TA rated up to 550 hp and the 8V-92TA at 735 hp are especially suitable for application requiring a compact high power-to-weight engine. The 6V-92TA has accomplished its first major US Army military programme award by being selected to power the US Army Armored Gun System light tank in the 19 to 23 ton (US) range. The 8V-92TA at 550 hp powers the Cadillac Gage Textron Stingray light tank which has been sold to Thailand. The 8V-92TA automotive engine powers the US Army HEMTT, US Marine Corps LVS trucks and new M1070 Heavy Equipment Transporter (HET) and Palletized Loading System (PLS) trucks for the US Army. In addition it also powers tanks, fire trucks, crash/fire/rescue vehicles and boats.



Typical Detroit Diesel Model 6V-53T developing up to 350 hp (261 kW) at 2800 rpm



Detroit Diesel Model 8V-92TA available at ratings of up to 735 hp (549 kW) at 2300 rpm with potential to 1000 hp (746 kW)

Future plans are to release the Series 92 family at 1.36 bhp/in3 the 6V-92TA at 750 hp, the 8V-92TA at 1000 hp and the 12V-92TA at 1500 hp. all with electronic controls.

Series 60

Relatively new to the market is the totally new-designed Series 60 which is the first production engine to offer integral electronic controls as standard equipment. Vital features of the engine include an overhead camshaft, parallel ports, an electronic control system and turbocharged air-to-air charge cooling.

This all-new 6-cylinder four cycle diesel can power military equipment up to 450 hp. The Series 60 was selected to power the US Army M915A2 and M916A1 line haul trucks and most recently US Air Force Rollover Snowplows.

In January 1990 the US Army Tank Automotive Command initiated a Contractor Performance Certification Program (CP²) for the Detroit Diesel family of engines for combat and military applications. Full contractor certification was awarded in December 1990 with DDC the first contractor to achieve certification over multiple product lines. The company is also pursuing accreditation of its quality systems under the International Organization (ISO) 9000 Quality Standard.

SPECIFICATIONS Series 53 6V-53T 350 hp

BASIC ENGINE 6V-53T NUMBER OF CYLINDERS BORE AND STROKE 98 × 114 mm DISPLACEMENT 5.21 **ENGINE TYPE** 2 cycle-V COMPRESSION RATIO 18:1 LENGTH 992 mm WIDTH 927 mm HEIGHT 1049 mm WEIGHT (dry) 769 kg RATED POWER OUTPUT

350 bhp (261 kW) at 2800 rpm gross power peak torque 768 lb ft (1041 Nm) at 1600 rpm

Series 92 8V-92TA 735 hp

BASIC ENGINE 8V-92TA NUMBER OF CYLINDERS BORE AND STROKE 123 × 127 mm DISPLACEMENT 12.11 ENGINE TYPE 2 cycle-V COMPRESSION RATIO LENGTH 1290 mm WIDTH 1087 mm HEIGHT 1057 mm WEIGHT 1134 kg **GROSS POWER** 735 bhp (545 kW) at 2300 rpm PEAK TORQUE

1777 lb/ft (2409 Nm) at 1800 rpm

Series 60 12.7 L 365-450 hp

BASIC ENGINE 4 cycle in-line MODEL 12.7 L NUMBER OF CYLINDERS AIR SYSTEM turbocharged air-to-air charge

cooling CONTROL DDEC BORE AND STROKE 130 × 160 mm DISPLACEMENT 12.71 COMPRESSION RATIO 15:1

LENGTH WIDTH HEIGHT WEIGHT (dry) **GROSS POWER** PEAK TORQUE **GROSS POWER** PEAK TORQUE **GROSS POWER** PEAK TORQUE GROSS POWER PEAK TORQUE **GROSS POWER** PEAK TORQUE

Series 71 12V-71TA 900 bhp BASIC ENGINE NUMBER OF CYLINDERS BORE AND STROKE DISPLACEMENT **ENGINE TYPE** COMPRESSION RATIO LENGTH WIDTH HEIGHT

991 mm 1067 mm WEIGHT (dry) 1315 kg **GROSS POWER** 900 bhp (671 kW) at 2500 rpm PEAK TORQUE 2080 lb/ft (2820 Nm) at 1600 rpm

1426 mm

953 mm 1259 mm

1225 kg

12V-71TA

108 × 127 mm

12

13.971

17-1

2 cycle-V

1524 mm

450 bhp (336 kW) at 2100 rpm

425 bhp (317 kW) at 2100 rpm

400 bhp (298 kW) at 2100 rpm

365 bhp (261 kW) at 2100 rpm

365 bhp (261 kW) at 1800 rpm

1450 lb/ft (1966 Nm) at 1200 rpm

1400 lb/ft (1898 Nm) at 1200 rpm

1400 lb/ft (1898 Nm) at 1200 rpm

1450 lb/ft (1898 Nm) at 1200 rpm

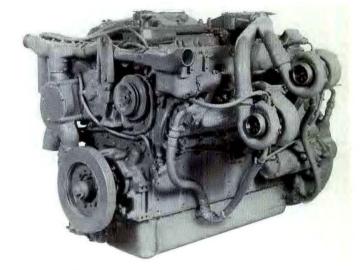
1450 lb/ft (1898 Nm) at 1200 rpm

Status: Production as required. In service with the United States Army and many other armed forces

Manufacturer: Detroit Diesel Corporation, 13400 West Outer Drive, Detroit,

Michigan 48239-4001, USA.

Telephone: (313) 592 5875 Telex: 432001



Detroit Diesel Model 12V-71QTA developing 900 hp (671 kW) at 2500 rpm as used in M47 and M48 tank repowers

NAPCO International Retrofit Power Packages

NAPCO International Incorporated of Minnesota has designed, in association with several other companies, a series of retrofit power packages for older armoured fighting vehicles such as the M24 and M41 light tanks, the M4. M47 and M48 medium tanks and the M74 armoured recovery vehicle.

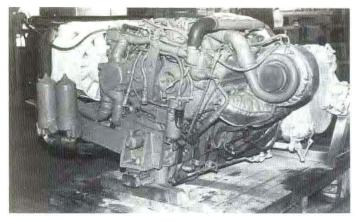
M47, M48 and Centurion Powerpack

At the time of its original design for the M48 tank this was known as the NDDA (NAPCO, Detroit Diesel, Airscrew Howden) diesel powerpack. When fitted to the M48 the automotive characteristics of the vehicle are raised to the standard of modern battle tanks, extending its combat effectiveness; in fact the NDDA powerpack would make the old M48 potentially as good as the M60A3 MBTs. The NDDA powerpack kit makes it possible to convert currently petrol-engined M48 series tanks to diesel power without structural modification to the hull. In this respect the NDDA retrofit differs radically from the US Army's own scheme to convert M48 tanks to M48A5 status by (among other things) the installation of the M60 powerpack, involving extensive cutting, welding and machining of the rear hull and engine decks of the M48 hull. As a result the NDDA powerpack can be retrofitted with a minimum of resources and therefore at a much lower cost. A similar modification using the Teledyne Continental AVDS-1790-2 series engine is described separately in this section.

The powerpack is based on a Detroit Diesel 12V-71QTA engine, an Allison Transmission CD-850-6 transmission and a British Airscrew Howden cooling system. These three basic components are combined in a single fully integrated unit which can be installed in the vehicle in one piece. It can also be operated outside the vehicle for test or diagnostic purposes. The powerpack is designed for mounting in the engine compartment using the existing Lord self-locking slide brackets and only two bolts. All connections for fuel, electrical, instrument and control systems are provided with quickdisconnect fittings for ease of powerpack changes in the field. As a result, the complete powerpack, with a dry weight of 3253 kg, can be changed in the field in approximately 30 minutes.

The basis of the powerpack is the Detroit Diesel 12V-71QTA diesel engine. This 12-cylinder, liquid-cooled, two-stroke uniflow diesel is the subject of a separate entry (as the 12V-71T), but the model used in the NDDA package is fitted with four turbochargers and an after-cooler as a means of further uprating. The 12V-71QTA is rated at 597 kW at 2500 rpm and has passed the NATO AEP 5 400-hour durability test at this rating. Further development may result in higher power output which is then used with the CD-850-6A1 transmission.

The transmission is the Allison CD-850-6 torque converter transmission which is used in the M60 series of tanks. It is very similar to earlier models in the CD-850 series used in the M47 and M48 tanks and armies already familiar with the M48 will have no problems with the CD-850-6 either in operation or maintenance. A modification kit is available to enable the



NAPCO M41 powerpack showing cooling system fans and radiator, CD-500 transmission and Detroit Diesel 8V-71T engine

original M48 transmission to be upgraded to the latest standard as an alternative to the procurement of new transmissions. In some of its other retrofits (the M47 tank and the LVTP5/H6) NAPCO has used a transfer case that eliminates the need for the transmission modifications when using the 12V-71QTA.

The Airscrew Howden cooling system has been specially designed to enable the NDDA powerpack to be retrofitted in M48 tanks without changing the profile of the engine compartment. It consists of two heat exchanger and fan assemblies mounted between the engine and transmission. Each assembly comprises an engine coolant radiator, a transmission oil cooler and a mixed flow fan. The radiator and oil coolers are mounted horizontally, the radiator above the oil cooler, and the fan mounted below them draws cooling air down through the radiator and then the oil cooler, after which it passes around the transmission and is discharged through the rear armoured covers. The mixed flow fans do not require stator vanes or an outlet casing, thus saving space and weight. The swirl of the discharged air also minimises any tendency to blockage at the outlet of a densely packed engine compartment. The hydrostatic fan drive allows the cooling power to be varied to suit operating conditions, and its efficiency is further increased by an oil/water heat exchanger.

The engine is fitted with two dry, two-stage air filters. The auxiliary power unit of the M48 has been eliminated, and provision has been made for a 300A generator or 650A alternator to be driven by means of a power takeoff

The road range of the M48 and the NDDA powerpack is estimated to be about 500 km, compared with the 100 km range of the gasoline-engined M48. At the same time, the 597 kW engine offers a higher gross power output than the M60's. The power available at the sprocket is greater because the efficient design of the cooling system demands less cooling power. As a result an M48 with the NDDA powerpack should be at least as mobile as the M60 series tanks, with a top road speed of 51 km/h and better acceleration

The NDDA powerpack can also be installed in the M47 and Centurion tanks

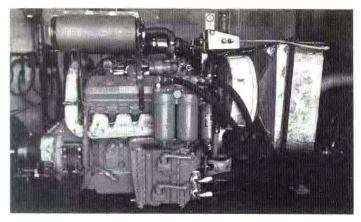
As of February 1993 this retrofit package had not been adopted by any

NAPCO M41 Light Tank Powerpack

The retrofit of the M41 light tank with the Detroit Diesel 8V-71T engine results in a vehicle with the same mobility as the original vehicle but with an operating range of over 450 km, compared with the 160 km of the sparkignition engined tank. The powerpack comprises the 8V-71T engine matched to the original CD-500 torque converter transmission by a NAPCO step-up gearbox. The powerpack is cooled by two axial flow fans and a matched radiator, and a power take-off drives a 650 A alternator which is cooled and



M8 (6 \times 6) armoured car of Colombian Army fitted with NAPCO supplied powerpack and TOW launcher



NAPCO powerpack ready for installation in M4 Sherman tank, M7 Priest or

lubricated by the main engine oil. Exhaust gas is used both for turbocharging and also to evacuate dust from the first stage of the two-stage air cleaner. This, together with the use of a water-cooled engine as opposed to the original air-cooled AOS-895 series engine, has made the re-engined M41 remarkably quiet in operation.

The retrofit requires an extensive but straightforward rework of the engine compartment. Cooling air is drawn down through the practically unaltered rear deck louvres. The fans force this air past the radiator and then discharge it through new armoured louvres on the right hand side of the engine compartment. The air cleaner is mounted on the track guard and can draw air from either the engine or the fighting compartment, as suits local conditions

When fitted with this powerpack the M41 has a maximum speed of 72.5 km/h. The modified fuel tanks contain some 500 litres of fuel which, at normal usage, gives an endurance of 1.04 battlefield days.

Details of the Detroit Diesel 8V-71T engine are given separately in this

This retrofit package will also fit the M42 SPAAG (tested by National Guard in USA, one purchased by Taiwan), M44 155 mm self-propelled howitzer (one powerpack was installed for trials in 1985) and the M52 105 mm self-propelled howitzer (one for trials in 1985).

As of February 1993 this retrofit package had not been adopted by any country.

NAPCO M4/M74/M7 Priest Powerpack

This powerpack is again based on the Detroit Diesel 8V-71T engine, but uses the existing transmission and steering unit. The 8V-71T engine, which is described separately in this section, is installed as a complete unit. The cooling system is designed to use the vehicle's existing radiator, to reduce costs and minimise installation difficulties. Using a specially designed air cleaner and intake selection valve, air can be drawn either from the crew compartment or through the engine compartment in a similar manner to that of the retrofitted M41. It has been possible to make use of the M4 series' existing transmission which was designed to handle up to 500 hp (373 kW), although few engines of this rating were available while the Sherman was in production. Matching the engine to the transmission only requires the drive shaft to be shortened. Re-engining with the 8V-71T gives an improvement in performance of about 30 per cent, which is similar to the improvement given by the installation of Cummins engines into Israeli variants of the M4 series. NAPCO has supplied a number of these repower packages to Portugal for installation in its M74 armoured recovery vehicles.

In 1987 an Asian country, believed to be Pakistan, completed an exhaustive 24 month trial of a 105 mm M7 self-propelled howitzer fitted with a repower package developed by NAPCO.

M113 Support/Conversion

NAPCO can supply virtually any spares required for the M113 and M113A1 family of tracked vehicles. It can also supply the complete diesel conversion package for the M113 as used by the US Army. This includes the diesel engine, automatic transmission, transfer case, cooling components and all other parts necessary for complete diesel conversion from the M113 to the M113A1.

NAPCO LVTP5

Following competitive trials, NAPCO delivered two repower packages for installation in LVTP-5 (Landing Vehicle Track Personnel) armoured amphibious assault vehicles of an undisclosed country, believed to be Taiwan.

The powerpack consists of a more fuel efficient Detroit Diesel Model 12V-71QTA diesel developing 750 hp coupled to the existing Allison Transmission Division of General Motors C-850-4B transmission via a transfer case. The fuel system has also been modernised.

For the first phase of the competition, three manufacturers submitted powerpacks for extensive trials. The NAPCO powerpack was selected and following formal acceptance with the two powerpacks delivered in 1991 a contract for 150 upgraded packages was awarded and final deliveries of these were made in 1993.

Hull layout of M47 tank fitted with NAPCO repower package

NAPCO M47 Tanks

In early 1986 the US Army Tank Automotive Command awarded a contract to the Tank Automotive Systems Group of NAPCO International to overhaul three M47 medium tanks for Somalia.

The package used in Somalia was based on the Detroit Diesel 12V-71QTA engine and Allison Transmission transmission described earlier in this entry. The major difference comes from the use of a NAPCO cooling system design and a different transfer case to match the engine and transmission. In this package the inclusion of an additional set of gearing allows the use of an M47's original CD-850-4A or B transmission or a new or upgraded CD-850-6.

In addition to overhauling the M47s, including the gun control equipment, NAPCO installed the new power packages and oversaw an operational test programme.

NAPCO Half-track Upgrade

Early in 1993 NAPCO commenced deliveries of 34 half-tracks to Mexico which had been overhauled and modernised in NAPCO facilities.

The original engine has been replaced by a Detroit Diesel Model 6V-53 diesel engine coupled to the original manual transmission. In addition the vehicle electrics, exhaust, cooling and fuel lines were upgraded or replaced.

NAPCO M60 MBT Upgrades

NAPCO can now supply packages to upgrade the M60A1 MBT to the M60A1 RISE (Reliability Improved Selected Equipment), the M60A1 RISE to M60A3 passive and the M60A3 passive to the M60A3 TTS (Tank Thermal Sight). The M60A3 was the final model of the M60 series to enter service with the US Army and was phased out of front-line service late in 1992.

The NAPCO kits contain all of the hardware necessary for the complete installation. New components are accompanied by new technical manuals, operators manuals, parts manuals, engineering data and instructions for handling of displaced components.

Technical assistance and training on vehicle conversion, operation and maintenance are available.

New suspension kits are also available including T142 and T97 track, roadwheels, support rollers, sprockets, idler wheels, idler arms, shock absorbers, torsion rods, roadwheel arms and all related assembly and service material.

NAPCO M48/M60 AVLB

In addition the company can provide kits for the conversion of M48 and M60 MBTs to the Armoured Vehicle Launched Bridge (AVLB) configuration.

Status: All the powerpacks described in this entry have been developed to prototype stage and are ready for production. In 1982 an M42 fitted with the same powerpack as the one successfully tested in the M41 light tank, but with modified cooling, underwent trials at Fort Bliss. This vehicle was also fitted with the Cadillac Gage weapon control system for improved target tracking. The Colombian Army has been supplied with 24 NAPCO repower kits for the M8 armoured car and M20 utility vehicle. These kits use the Detroit Diesel Corporation 4-53N engine and Allison Transmission AT-545 automatic transmission. The M41 retrofit package has been tested by Denmark, Spain (two purchased) and Thailand.

Manufacturer: NAPCO International Incorporated, 1600 Second Street South, Hopkins, Minnesota 55343, USA.

Telephone: (612) 931 2400 Telex: 290436

Teledyne Continental Motors Diesel Engines

Development

Teledyne Continental Motors, General Products (TCM), is currently producing the AVDS-1790 Series engine for combat vehicles in the 750, 908, 1050 and 1200 horsepower range. The AVDS-1790 Series is a military specification engine, combat proven and optimised for heavy, tracked vehicle operation. TCM has produced more than 44 000 AVDS-1790 Series engines, powering over 60 per cent of the free world's main battle tanks.

Vehicle	Engine type		
M46 tank	AV-1790		
M47 tank	AV-1790		
M48 tank	AV-1790		
LVTP5 amphibian	LV-1790		
M47 tank retrofits	AVDS-1790		
M48 tank retrofits	AVDS-1790		
M60 MBT	AVDS-1790		
M88 ARV	AVDS-1790		
M728 CEV	AVDS-1790		
CEV	AVDS-1790		
AVLB	AVDS-1790		
Merkava MBT	AVDS-1790		
Centurion MBT retrofits	AVDS-1790		
AMX-30 MBT retrofits	AVDS-1790		
T-Series retrofits	AVDS-1790		
M88A1E1 Improved			
Recovery Vehicle	AVDS-1790		

Main features of the AVDS-1790 Series can be summarised as: air cooling for engine/transmission oil, low voltage protection, automatic fuel/water separation, smoke generator, waterproof to 15 m, top-mounted fuel and electrical quick disconnects, high capacity electrical systems (300, 650 and 800 A), modular construction, high power-to-weight ratio, 60 per cent gradient and 30 per cent slope operation, cold starting aids and extreme weather operation (–62 to +60°C).

Red Seal production engines and Gold Medallion engine kit

In 1985, Teledyne Continental Motors, General Products (TCM), initiated a project to improve the reliability of their engines by beginning with an extensive failure analysis based on the engine reliability data. The results of this study indicated that corrections to a small number of engine parts would significantly increase RAM-D performance. These parts were redesigned, using new materials and processes, tested on engines and NATO certified by the US Tank Automotive Command (TACOM) in 1986.



M88A1 ARV is fitted with a TCM AVDS-1790-2DR diesel

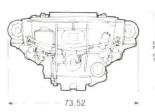
This new engine series is designated Red Seal and is available in all horsepower options. These engines exhibit twice the reliability and five times the durability of the RISE engine series. The Red Seal engines are warranted for 1000 hours of operation and have Mean Time Before Overhaul (MTBO) of up to 2550 hours.

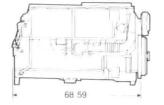
To increase the capabilities of fielded M60 and M48 engines, Gold Medallion kits were developed to upgrade engines during normal overhaul operations. When compared to the RISE series, both the Red Seal and Gold Medallion versions offer service parts commonality and are identical for purposes of training, operations and maintenance.

By late 1993 production of the AVDS-1790 series engine was still continuing at the rate of about one engine per day. At present the 1200 hp (894 kW) version is the most powerful model in production but work is now underway to increase the output to 1350 hp (1007 kW) and above.

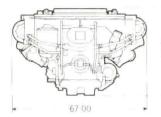
Vehicle modernisation

TCM has developed modernisation programmes for the US Army's M48/M60 series and other MBT's including the T-Series, AMX-30 and Centurion vehicles. These modernisation programmes utilise new technology and the advanced hardware and can provide for the upgrading of any or all of the vehicle subsystems, precisely fitted to customer requirements. TCM has integrated MBT modernisation programmes with the following systems: high performance powerpacks, dieselisation kits, main gun and armour



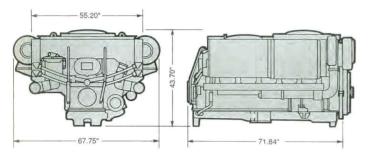


Teledyne AVDS-1790-2C series engine (dimensions given in inches)





Teledyne AVDS-1790-5A series engine as installed in Merkava Mk 1 MBT of Israeli Army (dimensions given in inches)



Teledyne AVDS-1790-8CR as installed in M88A1E1 armoured recovery vehicle (dimensions given in inches)

enhancement, fire-control systems, external suspension systems, fire suppression, night vision devices, turret drive and stabilisation.

Depending upon customer requirements, TCM can provide any level of technical support including total turnkey modernisation programmes encompassing completely upgraded vehicles utilising local labour. Details of Teledyne Continental Motors Corporation Centurion modernisation package are given in *Jane's Armour and Artillery 1992-93* page 158 while details of its Direct Fire Support Vehicles, the Armored Gun System, are given in the same volume pages 186 to 188.

TCM AVDS-1790-2

This 750 hp (559 kW) engine is available with a 300 A air-cooled generator (AVDS-1790-2D) or with a 650 A oil-cooled alternator (AVDS-1790-2C). An earlier version of this engine coupled with the CD-850-6A transmission was standard equipment on the M48, M60 and M88 vehicles. The latest engine (Red Seal) is in its third generation of product improvements for reliability and durability and is offered with a 1000 hour warranty.

TCM AVDS-1790-5A

This is an up-powered version of the AVDS-1790-2C with commonality of over 90 per cent between the two diesel-powered engines. The engine is rated at 908 hp (677 kW) and is installed in the Merkava Mk 1 MBT. The -5A is a good candidate for tank modernisations requiring additional horsepower with transmission options including the Allison Transmission CD-850-6B and XT-1410 or the Renk RK-304. The AVDS-1790-5A is available with the 1000 hour Red Seal warranty.

TCM AVDS-1790-8A

This is an up-powered version of the AVDS-1790-2C with commonality of over 70 per cent between the two diesel-powered engines. It has power increased to 1050 hp (783 kW), a 650 A alternator and similar dimensions to the AVDS-1790-2C. The AVDS-1790-8CR engine, configured with PTO was installed in the product improved M88A1E1 IRV. This engine received formal NATO certification from the Tank Automotive Command (TACOM) in April 1984. The AVDS-1790-8A is available with the 1000 hour Red Seal warranty.

TCM AVDS-1790-9A

This is an up-powered version of the AVDS-1790-2C with commonality of over 70 per cent between the two diesel-powered engines. It has power increased to 1200 hp (894 kW), a 650 A alternator and the same dimensions as the AVDS-1790-8CR. The AVDS-1790-9AR powers the Merkava Mk 3 MBT and received NATO certification from TACOM in February 1988. The AVDS-1790-9A is available with the 1000 hour Red Seal warranty.



Egyptian Army Ramses II MBT (T-54) which was upgraded by Teledyne Continental Motors, General Products

SPECIFICATIONS

Model
CONFIGURATION
CONSTRUCTION
CYLINDER DETAILS
bore
stroke

valve train

type

SWEPT VOLUME COMPRESSION RATIO FUEL SYSTEM ASPIRATION COOLING SYSTEM

POWER RATING max power max torque BSFC LENGTH WIDTH

HEIGHT WEIGHT APPLICATIONS

Model

COMPRESSION RATIO RATING max power max torque

Model

COMPRESSION RATIO RATING max power max torque

AVDS-1790-2 Series

90°, V-12 major components of aluminium

146 mm, carbon-silicon impregnated 146 mm 'Unisteel' cylinders, aluminium cooling fins

geared twin camshafts actuating 24 valves 1790 cu in (29.34 I) 16:1

mechanical injection twin turbocharger air-cooled by two geared engine driven

750 hp (559 kW) at 2400 rpm 2373 Nm at 1950 rpm 246 g/kWh at 2400 rpm 1.78 m

1.78 m 1.91 m 1.13 m 2223 kg

see description above for all applications

AVDS-1790-5A (intercooled) Details as for AVDS-1790-2 series except: 14.5:1

677 kW (908 hp) at 2400 rpm 2975 Nm at 2000 rpm

AVDS-1790-8DR (intercooled)
Details as for AVDS-1790-2 series
except:
14.5:1

783 kW (1050 hp) at 2400 rpm 3440 Nm at 1800 rpm



The Israeli Merkava Mk 3 MBT is powered by a TCM AVDS-1790-9AR diesel

Model

AVDS-1790-9A

Details as for AVDS-1790-2 series except:

13.0:1

RATING max power max torque

COMPRESSION RATIO

894 kW (1200 hp) at 2400 rpm 3932 Nm at 2000 rpm

Status: In production, in service with many countries including Israel and the United States.

Manufacturer: Teledyne Continental Motors, General Products, 76 Getty Street, Muskegon, Michigan 49442, USA.

Telephone: (616) 724 2151 Fax: (616) 724 2928

FMS Corporation AFV Upgrades

The FMS Corporation has developed a wide range of upgrade packages for full tracked armoured vehicles developed in the United States and significant quantities of these have been supplied to the US Army, NATO countries and countries in the Far East.

M60 MBT

In 1986, FMS was selected to be the prime contractor for material and technical assistance support for an Austrian joint venture of Steyr-Daimler-Puch and NORICUM for the conversion of the Austrian Army fleet of M60A1 MBTs to the M60A3 (passive) configuration which covered a total of 118 vehicles. The following M60 MBT conversions are currently being offered:

M60 basic to M60A1

M60A1 to M60A1 RISE

M60A1 RISE to M60A3 passive

M60A1 to M60A3 passive

M60 basic to M60A3 passive

M60A3 passive to M60A3 TTS (Tank Thermal Sight)

M60A3 TTS to M60A3 hybrid

The M60A3 hybrid includes a low profile commanders cupola, automatic fire supression, improved shoot-on-the-move capability, laser tank firecontrol system improvements, engine power uprated to 900 hp, interior turret-mounted 60 mm mortar, thermal imaging system options, improved turret race bearing and add-on armour of the conventional or explosive reactive type.

M113 APC

A wide range of upgrades are offered for this family of armoured personnel carriers as well as special purpose kits including a personnel heater, NBC protection, fire suppression system and various turrets. The upgrades currently offered include:

M113 to M113A1 (diesel)

M113 to M113A2 (diesel)

M113 to M113A3 (diesel) M113 to M113A2* (diesel)

M113A1 to M113A3 (diesel)

M113A1 to M113A2* (diesel) M113A1 to M113A2 (diesel) M113A2 to M113A3 (diesel) M113A2 to M113A2* (diesel)

The M113A2* features the Detroit Diesel 6V-53T Silver Star diesel developing 275 hp coupled to an Allison TX-100-1A transmission and the option of spall liners, bolt-on armour, external fuel tanks, NBC protection and a fire suppression system.

M109 self-propelled howitzer

A wide range of upgrades is available for the 155 mm M109 self-propelled artillery system, although FMS would not normally provide the actual cannon assembly as this is made by Watervliet Arsenal.

M108 to M109 (basic)

M109 (basic) to M109A1 PIP

M109 (basic) to M109A2/A3 mid-life

M109 (basic) to M109A4 HELP

M109 (basic) to M109A5 HIP I

M109 (basic) to M109A6 HIP II

M109A1 PIP to M109A2/A3 mid-life M109A2/A3 mid-life to M109A4 HELP

M109A4 HELP to M109A5 HIP I

M109A4 HELP to M109A6 HIP II

M48/M60 Armoured Vehicle Launched Bridge

FMS can provide a kit to convert M48 or M60 MBT's into Armoured Vehicle Launched Bridges. The package would normally include new engine, transmission, bridge and bridge launcher system.

Status: Production as required. Known customers include Netherlands (Armored Infantry Fighting Vehicle), Norway (M109), Taiwan (M48 AVLB), Thailand (M113 to M113A1 plus) and USA (up-armour kits for M2/M3 Bradley fighting vehicles and kits to upgrade M113 series vehicles to the more recent M113A3 standard).

Manufacturer: FMS Corporation, 12637 Beatrice Street, PO Box 66999,

Los Angeles, California 90066-0999, USA.

Telephone: (310) 306 2800 Fax: (310) 306 5108



Key parts of the FMS Corporation M113A3 APC conversion kit



Bradley fighting vehicle fitted with applique armour kit from FMS Corporation

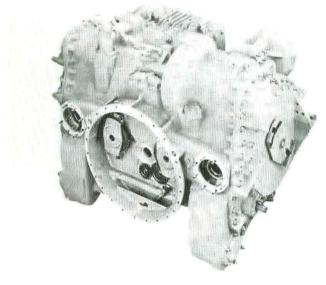
Allison Transmission

Allison Transmission manufactures a complete range of transmissions, some of which have been developed specifically to meet military requirements while others were developed for civilian use but are also widely used in military vehicles.

The company provides automatic transmissions for virtually every AFV

built for the US Army with the exception of the M2/M3 Bradley which has a General Electric HMPT-500 automatic transmission.

It is also providing the new automatic transmission to both contenders, Cummins Engine Company and General Electric, for use in the Advanced Integrated Propulsion System (qv).



CD-850 series crossdrive transmission which is installed in many tanks including M60 series and is also now manufactured under licence in Spain by Sociedad Anonima Placencia des las Armas



X-300-4B transmission which is installed in UK Warrior and manufactured under licence in the UK by Perkins

Model	Туре	Original application	Current use
AT-545	automatic, 4F1R gears	civilian	Cadillac Gage V-150, BDX, GKN Defence Saxon, Valkyr, Commando Scout, 25K Loader, MB4 and TA12 Tow Tractors
MT-643	automatic, 4F1R gears	civilian	RAM V1, MOWAG Spy, Timoney, Shoet, Cascavel, Urutu, VTP-1 V-300 Commando, M35A2C truck, TA20-35, US Navy Pumper, R9 Refueller
MT-653-DR	automatic, 5F1R gears	civilian	M24 Chaffee (Norway), Dragoon, MOWAG Piranha, LAV-25
CD-850-4/4A/4B	power shift, crossdrive, 2F1R gears	military	M47, M48 tanks
CD-850-4B	as above	military	M48A1 tank, LVTP5
CD-850-5	as above	military	M48A2 tank, LVTP5
CD-850-6	as above	military	M48A3, M60, upgraded Centurion
CD-850-6A	as above	military	M60A1, M60A3, RKM M47, M48A5, M47M, Centurion repower (Israel, Jordan, Sweden)
CD-850-6B	as above	military	Merkava MBT
CD-500-3	power shift, crossdrive, 4F2R gears	military	M41 tank, M44 and M52 SPG, M42 SPAAG
CLBT-750	automatic, 5F1R gears	civilian	M911 truck
CLBT-6061	automatic, 6F1R gears	civilian	MX Missile Hauler
HT-740-D	automatic, 4F1R gears	civilian	lkv-91 tank destroyer, M977 Series, LVS,
111 110 5	automatio, 41 Tri godio	divinari	US Army PLS development
HT-750-DRD	automatic, 5F1R gears	civilian	MOWAG Shark, P-8, P-12 & P-19 Crash Trucks, P-18 Hydrant Truck, US Army Tactical Fire Truck, US Air Force Minuteman Missile Transporter
HT-754-CR	automatic, 5F1R gears	civilian	M915A1, Dept of Energy Nuclear Water Hauler
MT-654-CR	automatic, 5F1R gears	civilian	M939 Series, R-11
TX-100-1	automatic, 3F1R gears	military	M113A1 Series, OTO Melara AIFV, Iveco 6064, Lynx
TX-100-1A	automatic, 3F1R gears	military	FMC AIFV
TX-200	automatic, 6F1R gears	military	M113 Series
TX-200-2A	automatic, 6F1R gears	military	HWK-10 Series
TX-200-4A	automatic, 6F1R gears	military	FV432 APC, Abbot SPG
X-300-4A	automatic, 4F2R gears	military	HSTV-L
X-300-4B	automatic, crossdrive, 4F2R gears	military	Warrior (produced in UK), AMX-30 (produced in Spain), and gv following entry
XTG-250-2A	power shift, crossdrive, 4F1R gears	military	M551 Sheridan
XTG-411-2A	power shift, crossdrive, 4F2R gears	military	M107, M108, M109 and M110 SPG, M992 FAASV, M578 ARV,
XTG-411-4	power shift, crossdrive, 4F2R gears	military	Tank repowers, Stingray light tank
X-200-4	automatic, crossdrive, 4F2R gears	military	M113A3 Series and M730A2 Chaparral system (qv)
XT-1410-4	power shift, crossdrive, 3F1R gears	military	M88 ARV
XT-1410-5	as above	military	Counter Obstacle Vehicle, M88A1E1 ARV
X-1100-3B	automatic, crossdrive, 4F2R gears	military	M1, M1A1, M1A2 MBT (qv)
X-1100-1A	automatic, crossdrive, 4F2R gears	military	HIMAG 'A'

NB: 3F1R (etc) = 3 forward and 1 reverse gears

Status: Production.

Manufacturer: Allison Transmission, PO Box 894-L7, Indianapolis, Indiana

46206-0894, USA

Telephone: (317) 242 2715 Telex: 276411 TWX: (810) 3413 120



TX-100 series transmission which is installed in M113 series

Allison Transmission X-200-4 Transmission

Development/Description

The X-200-4 automatic transmission is a member of a complete family of transmissions which includes the X-300 (selected for the UK Warrior), and the X-1100 (installed in the M1A1 MBT).

The X-200-4 entered production in mid-1986 initially to upgrade the M730 Chaparral surface-to-air missile system and in this application it is coupled to a Detroit Diesel 6V-53T 'forward plan' engine developing 275 bhp at 2800 rpm. The X-200-4 can be matched for engines rated up to 350 bhp. The X-200-4 has been designed for vehicles in the 9- to 18-ton range.

Main advantages claimed by the manufacturer can be summarised as: four forward and two reverse speeds, hydrostatic steering which permits smoother turning with less effort by the driver and reduced shock loads on the suspension system, eliminates need for transfer case, steering differential and spot brakes (so saving weight), greater drive line efficiency resulting in more usable sprocket horsepower and fuel savings, increased reliability and durability

SPECIFICATIONS

RATING

up to 350 bhp (261 kW) Gross engine power Max input speed range 2600 to 2800 rpm up to 16 tons (US) Vehicle weight MOUNTING SAE 3 flywheel housing with spline coupling drive, output trunnions each side TORQUE CONVERTER single stage, 3-element, polyphase STALL TORQUE RATIOS TC 360-3/32:1

AUTOMATIC LOCK UP CLUTCH **GEARING**

effective in 2nd to 4th ranges

type constant mesh, spur type, planetary 1st gear 4.16:1 2nd gear 2.34:1 3rd dear 1.46:1 4th gear 1 04:1 1st reverse gear 6.62:1

2nd reverse gear 2.16:1 (optional) BRAKES multiple wet plate PTO converter driven two (optional)

LENGTH 673 mm 699 mm

WIDTH HEIGHT 691 mm WEIGHT (dry) 443 kg

X-300-4B

In the 1970s Rolls-Royce, subsequently Perkins Engines (Shrewsbury). signed a licence agreement with the now Allison Transmission, for final development and production of the version for Warrior designated the X-300-4B. Full-scale production of this commenced in the UK in 1986.

The X-300-4B is a fully automatic crossdrive transmission offering four forward and two reverse ranges driven through a torque converter and lock up clutch. Steering is infinitely variable with true pivot turn in neutral. achieved with hydrostatically controlled double differentials. Service and parking brakes are incorporated and are hydraulically applied with mechanical back-up. A generous live PTO facility is provided for, together with a range of input torque converters to suit most engines. The X-300-4B is suitable for front or rear installation.

Following trials, the Perkins licence manufactured X-300-5 automatic transmission was selected for all production versions of the Swedish Army's new Combat Vehicle 90. First production X-300-5 transmissions were shipped to Sweden by Perkins in 1993.

SPECIFICATIONS		
MODEL	X-300-4B	X-300-5
GEAR RATIOS		
1st gear	4.16:1	4.16:1
2nd gear	2.00:1	2.00:1
3rd gear	1.28:1	1.28:1
4th gear	0.86:1	0.86:1
1st reverse gear	5.75:1	5.75:1
2nd reverse gear	1.43:1	1.43:1
TORQUE CONVERTER	single stage, mult	i-phase with lock up clutch
MULTIPLICATION		
AT STALL	2.70:1	2.35:1
STEERING	Infinitely variable with 'pivot steer' in	controlled double differentials n neutral
RATING (INPUT)	300-520 kW (400	-700 bhp)
BRAKES	wet multi-plate wi actuation, 0.5 g ra	th hydraulic and mechanical ating
POWER TAKE OFF	1.08 × engine spe	eed, 100 kW (150 bhp) rating

Status: Production. Manufactured under licence in the UK by Perkins for the British Army Warrior mechanised combat vehicle and the Swedish Army's Combat Vehicle 90. Also manufactured under licence in Spain by Sociedad Anonima Placencia de las Armas (qv Spain) for installation in upgraded AMX-30 MBTs of the Spanish Army.



The Perkins manufactured X-300-5 automatic transmission will be installed in all production Combat Vehicle 90's of the Swedish Army



Manufacturers: Allison Transmission, PO Box 894-L7, Indianapolis, Indiana 46206-0894, USA.

Telephone: (317) 242 2715 Telex: 276411 TWX: (810) 3413 120

Perkins Engines (Shrewsbury) Limited, Defence Sales Division, Shrewsbury

Telephone: (0743) 212000 Telex: 35171/2 Fax: (0743) 212701

Sociedad Anonima Placencia de las Armas, Apartado de correos no 8, Andoain (Guipuzcoa), Spain.

Telephone: (43) 592011 Telex: 36176 SAPA-E

X-200-4 fully automatic transmission which entered production in 1986

Allison Transmission X-1100-3B Automatic Transmission

Development/Description

The original X-1100 automatic transmission was developed in the 1970s and installed in both competing prototypes of the XM1 MBT built by Chrysler Defense and General Motors.

The Chrysler Defense XM1 was subsequently selected and production of the X-1100-3B transmission commenced in September 1979. The configuration developed for the heavier M1A1 MBT was introduced into production in April 1985 and incorporates changes that further improve the efficiency and reliability of the transmission.

Although current production of the X-1100-3B transmission is configured for application with the AGT 1500 gas turbine as installed in the now General Dynamics, Land Systems Division, M1A1 MBT, the X-1100 centre section was designed so that it can be adapted for other engines such as gas turbine, rotary or diesel of comparable power ratings through the use of different input modules that are compatible with the particular engine and vehicle installation requirements.

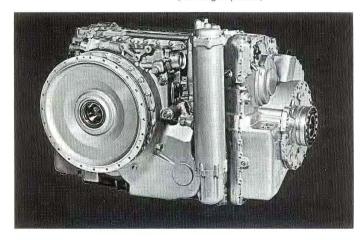
SPECIFICATIONS

GROSS ENGINE POWER RATING MAXIMUM INPUT SPEED RANGE VEHICLE WEIGHT

1500 hp (1120 kW) 2000 to 3000 rpm 50 to 70 tons (US)

Torque converter

TORQUE CONVERTER TYPE STALL TORQUE RATIO AUTOMATIC LOCK UP CLUTCH single stage, 3-element, multi-phase 1.80:1 to 3.30:1 effective in 2nd, 3rd, 4th ranges (1st range optional)



Range gearing

TYPE constant mesh, spur type, planetary first gear ratio 5.88:1 second gear ratio 3.02:1 third gear ratio 1.89:1 fourth gear ratio 1.28:1 reverse-1 8.30:1 reverse-2 2 35:1 RANGE CONTROLS automatic, 1-4, 2-4, N, R1-R2

Steering

TYPE infinitely variable, hydrostatically controlled, differential 2.59:1 first ratio second 1.59:1 1.33:1 third fourth 1.21:1 pivot neutral 3.50:1 reversereverse-1.40:1

Braking

TYPE multiple plate, oil cooled hydraulic power supply mechanically applied power take-off provisions front, two rear 1.67 × input speed 2.37 × input speed

Oil system

oil type MIL-L-2104D, grade 30, MIL-L-46167 artic

capacity (excluding external circuit) 150 I

filter inted

integral, full flow, replaceable dual

elements

Weight (dry) 1960 kg

Status: In production. Installed in M1, M1A1 and M1A2 MBTs.

Manufacturer: Allison Transmission, PO Box 894-L7, Indianapolis, Indiana 46206-0894, USA.

Allison Transmission X-1100-3B automatic transmission

GE HMPT-500 Transmission

Development/Description

The HMPT-500 hydromechanical transmission was developed under contract to the US Army Tank Automotive Command and after trials with prototype systems was selected for the M2/M3 FVS in 1977. By early 1993 7500 HMPT-500 transmissions had been built and production was running at 88 a month.

The HMPT-500 automatically determines speed ratio and engine output based on throttle position and vehicle load, and transmits power with infinitely variable ratios through three forward and one reverse speed ranges. Changes between ranges are made with no change in ratio or interruption in power flow. It provides maximum steering torque in all ratios with a large track speed differential and dynamic braking with full engine retarding torque and hydrostatic retarding.

The design incorporates service brakes for stopping and parking the vehicle which are oil cooled and mechanically actuated, disconnect clutch for starting engine and towing the vehicle, tow pump for tow starting the vehicle with an inoperative electrical system and a PTO for operation of engine-driven accessories.

The original HMPT-500 has now been replaced in production by the upgraded HMPT-500-3 and this is currently installed in the latest production M2 Infantry Fighting Vehicles, M3 Cavalry Fighting Vehicles and Multiple Launch Rocket Systems. Over 2000 of the uprated 600 hp HMPT-500-3 transmissions have been produced. It has also been fitted to the prototype of the private venture Vickers Defence Systems VFM Mk 5 battle tank and more recently it has been selected by the FMC Corporation for the XM8 Armored Gun System (AGS) which has been ordered for the US Army.

More recent applications include a T-54/T-55/T-62 repower in which the

transmission is coupled to a Cummins diesel engine and the General

Dynamics/Teledyne Continental Motors Armored Gun System.

The HMPT-500 is also manufactured in the United Kingdom for all European built Multiple Launch Rocket Systems. David Brown Vehicle Transmissions and Self-Changing Gears hold the licence. Under current contracts David Brown Vehicle Transmissions is to complete 462 HMPT-500 transmissions by mid-1993 of which 367 are for production MLRS systems, and 95 initial spares. This has an input rating of up to 447 kW (600 hp). A kit can be used to upgrade early HMPT-500s to this new configuration.

HMPT-500-4

For applications in vehicles in the 36 288 kg, 800 hp class, General Electric has developed the HMPT-500-4 automatic transmission under contract to the US Army Tank Automotive Command. Vehicle trials have been completed in an automotive test rig and production can commence on receipt of orders.

Status: In production. Installed in M2 Infantry Fighting Vehicle, M3 Cavalry Fighting Vehicle and Fighting Vehicle Systems Carrier, which is used for the MLRS System. Selected for XM8 Armored Gun System.

Manufacturers: General Electric Company, Defense Systems Department, 100 Plastics Avenue, Pittsfield, Massachusetts 01201, USA. Telephone: (413) 494 3405 Telex: 951315 Fax: (413) 494 3791

David Brown Vehicle Transmissions Limited, Park Road, Huddersfield HD4 5DD, UK.

Telephone: (0484) 422180 Fax: (0484) 435292



Sectioned HMPT-500-3 transmission showing main hydraulic propulsion and steering assemblies

SPECIFICATIONS	SPE	CIF	ICAT	IONS
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INPUT RATING 447 kW (600 hp) 2600 rpm speed OUTPUT RATING 15 150 Nm max torque

max forward speed 3300 rpm max reverse speed 540 rpm steering torque per side 9200 Nm

WEIGHT (dry) 875 kg PTO full power,

SERVICE AND PARKING

BRAKES

constant running

mechanically actuated, oil-cooled

multiple disc

DYNAMIC BRAKING

STEERING

INPUT DISCONNECT

CONTROL

LENGTH WIDTH HEIGHT

full engine-retarding torque.

plus limited hydrostatic retarding infinitely variable ratio hydromechanical,

fully regenerative, without use of brakes or clutches

hydraulically actuated clutch to

disconnect power train for reduced cold-weather engine cranking

torque

hydraulic control automatically schedules

engine speed and transmission ratio for best performance

817 mm 1016 mm 724 mm

GE HMPT-1000 Transmission

Development/Description

The HMPT-500-3 transmission, covered in the previous entry, is coupled to engines with an input rating of up to 447 kW (600 hp). Using the same technology, the Defense Systems Department of General Electric has more recently developed the HMPT-1000 automatic transmission as a private venture.

The HMPT-1000 is being offered as a compact, low-profile alternative for self-propelled artillery systems and other medium-sized armoured vehicles.

For trials purposes a powerpack consisting of a Mack E9 diesel, GE HMPT-1000 automatic transmission and a new cooling system, has been installed in an M103 heavy tank chassis to give a gross vehicle weight of 45 tons (US).

SPECIFICATIONS

HEIGHT

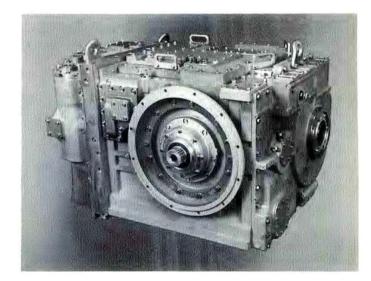
INPUT RATING POWER, net hp (kW) 1250 (933) SPEED, rpm 2100 to 3200 **OUTPUT RATING** max torque lb ft (Nm) 19 000 (25 750)

max forward speed, rpm max reverse speed, rpm 3900 steering torque per

11 400 (15 500) side lb ft (Nm) WEIGHT dry 1270 kg LENGTH 1.219 m WIDTH 757 mm

Status: Undergoing trials. Not yet in production or service. The Mack E9/ HMPT-1000 powerpack is scheduled to undergo trials by the US Army in 1993 as part of the Medium Integrated Propulsion (MIPS) programme

761 mm



General Electric HMPT-1000 automatic transmission

Manufacturer: General Electric Company, Defense Systems Department, 100 Plastics Avenue, Pittsfield, Massachusetts 01201, USA Telephone: (413) 494 3405 Telex: 951315 Fax: (413) 494 3791

Tracks

GERMANY

Diehl Track System

Description

The Tracks Division of Diehl has been involved in the design, development and production of tracks for armoured vehicles since 1959. The production facilities for Diehl tracks comprise four factories: the Blankenheim factory produces the special rubber compounds necessary to meet the strenuous demands made by armoured vehicle tracks and the factory at Mariahutte produces steel components such as connectors, track pins, track pad plates and drive sprockets. Remscheid is the centre of the Tracks Division and provides the main administration and research facilities, while track bodies are made in the Remscheid steel foundry with subsequent machining also taking place at Remscheid in addition to the vulcanisation of track pads and final assembly, preservation and packaging.

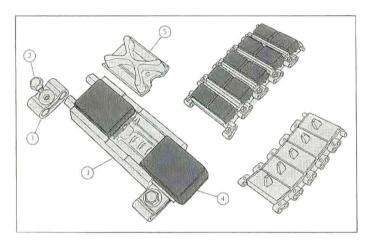
The essential parts of the Diehl double pin tracks are the cast body, the pins with vulcanised rubber bushings, different types of forged connectors, the Diehl patented slide-in track pads. Diehl tracks represent the only systems which can install so-called mud or snow cleats to increase traction under severe cross-country conditions.

Developments

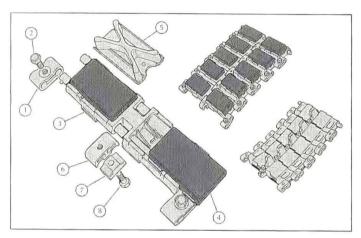
Innovations include snow cleats for high-speed use, new double pin track with mesh of sprocket teeth in track body (Diehl patent), noise and vibration damping systems in the final drive area and new rubber-textile tracks for lightweight vehicles.

Status: In production. In service with the German Army and many other countries.

Manufacturer: Diehl Remscheid, Tracks Division, Vieringhausen 118, PO Box 10 02 69, D-5630 Remscheid 1, Federal Republic of Germany. Telephone: (02191) 791-1 Telex: 8/513800 DIE D Fax: (02191) 791-282



Double pin track for medium vehicles such as M109 with two insertable pads and two end connectors. Diehl System Track 109 showing main components (1) end connector (2) bolt (3) body with integral centre guide (4) track pad and (5) grouser



Double pin track for heavy vehicles M48, M60 and M88 with two insertable tracks, one middle connector and two end connectors. Diehl System Track 208 showing main components (1) end connector (2) bolt (3) body with integral centre guide (4) track pad (5) grouser (6) centre connector (outer part) (7) centre connector (inner part) and (8) bolt



Diehl System Track 129 for Swedish Combat Vehicle 90



Diehl Track 640A for Leopard 1 MBT stripped down

SPECIF	CATIONS									
	Vehicle	Diehl	Туре	Width	Weight	Track	Pads/	Pad	Status	Remarks
No.		No.		mm	kg/m	shoes/ vehicle	track shoe	type		
I Fighti	ng Vehicles Main B	attle Tank	s			venicle	Silve			
1	Leopard I	640	d	548	154	168	2	ch	se	NATO Standard Track
2	Leopard I	139	d	548	123	168	_	V	se	Dutch Army only
3	Leopard II	570	d	635	182.5	164	2	ch	se	NATO Standard Track
4	Strv 103S	570	d	635	181.5	122	2	ch	se	
5	AMX-30	233	d	570	150	167	2	ch	se	
6	TAM	528	d	500	124	182	2	ch	se	
7	M48	108	d	711	168	156	_	V	se	equal to US T97E2, also for M60
8	M48	208	d	635	183	150	2	ch	se	The state of the s
9	M60	208	d	635	183	156	2	ch	se	replacing type 108
10	Centurion	107	S	552	156	218	3	V	se	7
11	Centurion	207	s	552	174	192	2	ch	se	
12	OF-40	840	d	548	162.4	170	2	ch	se	
13	EE-TI Osorio	234	d	570	150.2	182	2	ch	n.se	
14	T-54/T-55/Type 59		d	548	168	156	2	ch	n.se	
15	T-62	159	d	548	168	156	2	ch	n.se	
16	M1	570	d	635	181	164	2	ch	n.se	
10		370	u	000	101	104	_	GIT	11.50	
	and Light Tanks	200		455	155	100	-	2		
1	Marder 1	828	d	450	120.4	182	2	ch	se	
2	M41	126	S	545	128	150	1	ch	se	equal to US T91E3
3	M41	226	d	500	124.3	158	2	ch	se	replacing type 126
4	M24	103	d	381	88.9	146	2	ch	se	
5	SPZ 4K 3F	124	d	381	73	146	_	V	se	
6	SPZ 4K 3F	224	d	381	89	156	2	ch	se	
7	PT-76	155	S	360	59.9	192	1	ch	se	
8	SPz 90	129	d	540	102	186	2	ch	n.se	(Stridsforden 90)
9	M2 Bradley	129	d	520	108	173	2	ch	n.se	
10	Ikv-91	224	d	449	93	170	2	ch	n.se	
III Ligh	t Tanks									
1	AMX-13	217	S	350	64.7	170	1	V	se	
2	AMX-13	417	S	350	66.2	170	1	ch	se	replacing type 217A
3	AMX-10P	135	d	420	84	142	1	ch	se	replacing type 2177
4	M113/AIFV	213	d	379	67.1	131/136	1	ch	se	Dutch Army YPR 765
5	M113	213	d	379	61.8	131	1	ch	se	German and Danish Army only
6	M113	213	d	379	63.7	131	1	ch	se	including group vehicles
7	Scorpion	338	d	379	49.2	124	1	ch	n.se	including group vehicles
8	EE-T4	338	d	267	44.4	_	1	ch	n.se	prototype vehicle
		000	u	201	1.4.4			CIT	11.30	prototype vertice
	lery vehicles									
2	JPz Kan	228	d	447	111.3	172	2	ch	se	
3	JPz Rak	228	d	447	111.3	172	2	ch	se	
4	MLRS	129	d	520	108	184	2	ch	se	German Army
5	Palmaria	840	d	548	162.4	190	2	ch	se	
6	M107/110	228	d	447	111.3	153	2	ch	se	German Army
7	M107/110	828	d	450	120.5	157	2	ch	se	Dutch and British Army
8	M109/108	109.1	d	396.5	104.8	152	2	ch	se	
9	M109/108	109.2	d	396.5	104.8	152	2	ch	se	cone shaped insertion of pad
10	M109/108	309	d	397	97.9	152	2	ch	n.se	bayonet-like cone shaped insertion of pad
V Spor	ial-to-purpose and	cupport v	obiolog							
1	M88	208	d	635	183	165	2	ch	se	
2	Greif	224	d	381	89	156	2	ch	se	
3	M578	828	d	450	120.5	157	2	ch	se	
4	Gepard	640	d	548	154	168	2	ch	se	
5	Roland	828	d	450	120.4	182	2	ch	se	
6	M992	109.1	d	396.5	104.8	-	2	ch	se	prototype vehicles
7	M992	109.1	d	396.5	104.8	_	2	ch	se	prototype vehicles
8	M992	309	d	397	97.9	_	2	ch	se	prototype vehicles
9	Wiesel	522	d	200	15.82	102	1	V	se	German Army
	. 110001	OLL	u	200	10.02	, 02			36	Soman Army

LEGEND

Column D s = single pin track d = double pin track

Column I ch = changeable pad v = vulcanised track shoe

Column J se = serial n.se = not serial

ISRAEL

Urdan Track Shoes

Description

Within Urdan Industries, Suspension & Parts Industries (SPI) produces a wide range of metal parts and assemblies of suspension components for tracked armoured vehicles, including road wheels, sprockets, track and shoes. Urdan TGL is responsible for the rubberising of track shoes. In addition to manufacturing an extensive range of track shoes, Urdan Industries

also manufactures road wheels for many types of armoured fighting vehicles (including the M1 MBT, M2 IFV, M3 CFV, M4 Sherman tank, M9 ACE, M24 light tank, M41 light tank, M42 SPAAG, M47 tank, M60 MBT, M88 ARV, M113 series of APC, M107, M108, M109 and M110 self-propelled artillery weapons, M551 light tank, M578 armoured recovery vehicle and the Centurion MBT), rotary shock absorbers, final drive sprockets and road wheel housing assemblies. Brief specifications of the track shoes are given in the table below:

TO	nc	_	=
1 (O		J

APPLICATION M4 Sherman, M51 and M74 ARVs

 WEIGHT PER SHOE
 26.76 kg

 PITCH
 152 mm

 WIDTH
 584 mm

 GROUSER HEIGHT
 38 mm

 PIN DIAMETER
 31.75 mm

 GUIDE TYPE
 removable centre

 BUSHING TYPE
 rubber

T85E1

APPLICATION M24 light tank and variants

WEIGHT PER SHOE 11.7 kg
PITCH 139.7 mm
WIDTH 355 mm
GROUSER HEIGHT 31.75 mm
PIND DIAMETER 24.4 mm
GUIDE TYPE integral centre
BUSHING TYPE rubber

T97E2

APPLICATION M48 and M60 MBTs

 WEIGHT PER SHOE
 27.8 kg

 PITCH
 176 mm

 WIDTH
 711 mm

 GROUSER HEIGHT
 38 mm

 PIN DIAMETER
 31.75 mm

 GUIDE TYPE
 removable centre

 BUSHING TYPE
 rubber

T130E1

APPLICATION M113 family of APC

WEIGHT PER SHOE 9.38 kg
PITCH 152 mm
WIDTH 381 mm
GROUSER HEIGHT 32.54 mm to 55.56 mm

PIN DIAMETER 15.95 mm
GUIDE TYPE integral centre
BUSHING TYPE rubber

T136
APPLICATION M108 and M109 SPH

 WEIGHT PER SHOE
 15.87 kg

 PITCH
 152 mm

 WIDTH
 381 mm

 GROUSER HEIGHT
 38.1 mm

 PIN DIAMETER
 28.62 mm

 GUIDE TYPE
 integral centre

 BUSHING TYPE
 rubber

T156

 APPLICATION
 M1 MBT

 WEIGHT PER SHOE
 26.76 kg

 PITCH
 193.6 mm

 WIDTH
 635 mm

 GROUSER HEIGHT
 33.78 mm

 PIN DIAMETER
 34.89 mm

 GUIDE TYPE
 removable centre

AMX-30

BUSHING TYPE

APPLICATION AMX-30 MBT and variants

rubber

 WEIGHT PER SHOE
 19.2 kg

 PITCH
 160 mm

 WIDTH
 196 mm

 GROUSER HEIGHT
 27 mm

 PIN DIAMETER
 20 mm

 GUIDE TYPE
 integral centre

T84E1

APPLICATION M26, M46 and M48 tanks and variants

 WEIGHT PER SHOE
 22.95 kg

 PITCH
 152 mm

 WIDTH
 584 mm

 GROUSER HEIGHT
 38 mm

 PITCH
 31.75 mm

 GUIDE TYPE
 removable centre

 BUSHING TYPE
 rubber

T91E3

APPLICATION M41 light tank, M42 SPAAG, M44 and M52 SPG, M59 and M75 APC

rubber

 WEIGHT PER SHOE
 18.59 kg

 PITCH
 152.4 mm

 WIDTH
 533 mm

 GROUSER HEIGHT
 38 mm

 PIN DIAMETER
 22.3 mm

 GUIDE TYPE
 integral rubber

T10

BUSHING TYPE

APPLICATION M88/M88A1 ARV
WEIGHT PER SHOE 29.93 kg
PITCH 179 mm
WIDTH 711 mm
GROUSER HEIGHT 38 mm
PIN DIAMETER 34.89 mm
GUIDE TYPE removable centre

BUSHING TYPE rubber

T132E1

APPLICATION M107 and M110 SPG, M578 ARV

WEIGHT PER SHOE 15.73 kg
PITCH 152 mm
WIDTH 457 mm

GROUSER HEIGHT 39.68 mm to 61.91 mm
PIN DIAMETER 22.22 mm
GUIDE TYPE integral centre
BUSHING TYPE rubber

T142

APPLICATION M48 and M60 MBTs

WEIGHT PER SHOE 34.37 kg
PITCH 176 mm
WIDTH 711 mm
GROUSER HEIGHT 38.1 mm
PIN DIAMETER 31.75 mm
GUIDE TYPE centre guide
BUSHING TYPE rubber

AMX-13

APPLICATION AMX-13 light tank and variants WEIGHT PER SHOE 7.66 kg

| 122.23 mm | 122.

Centurion

APPLICATION Centurion MBT and variants WEIGHT PER SHOE 19.18 kg

 PITCH
 139.7 mm

 WIDTH
 610 mm

 GROUSER HEIGHT
 63.5 mm

 PIN DIAMETER
 25.4 mm

 GUIDE TYPE
 integral centre

OT-62

APPLICATION WEIGHT PER SHOE PITCH

PITCH WIDTH GROUSER HEIGHT PIN DIAMETER

GUIDE TYPE

OT-62 APC and variants

12.88 kg 128 mm 352 mm 39.68 mm 15.87 mm 2 integral guides T-62

WIDTH

APPLICATION WEIGHT PER SHOE PITCH

GROUSER HEIGHT PIN DIAMETER GUIDE TYPE T-62, T-55 and T-54 MBTs

14.65 kg 137.16 mm 580 mm 47.62 mm 22.22 mm integral centre

Status: Production as required. In service with Israeli Army and also exported.

Manufacturer: Urdan Industries Limited, Industrial Zone, IL-42378 Netanya, Israel.

Telephone: (972) 53-338074 Telex: 341822 UASF-IL

Fax: (972) 53-610246

ITALY

Sekur Track Links

Description

Sekur SpA, part of the Pirelli Group, has been involved in the design, development and production of track links and road wheels since 1960 and currently manufactures the following tracks for armoured fighting vehicles. These tracks are also available as individual components such as track shoe, bushings, pads, nuts and bolts.

Vehicle

Leopard 1 MBT M47 tank (T84E1) M60 MBT (T97E2) M109 SPH (T136) M113 APC (T190E1) Scorpion



Sekur track shoe assembly for M60 MBT showing main components

Status: In production. In service with the Italian Army and other countries.



Sekur track shoe assembly for Leopard 1 MBT showing all components

Manufacturer: Sekur SpA, Via di Torrespaccata 140, I-00196 Rome, Italy. Telephone: (06) 260046 Telex: 611084 PIAVRO - I

KOREA, SOUTH

Lucky-Goldstar International Corporation Track Shoes

Description

The Lucky-Goldstar International Corporation is the only qualified manufacturer of track shoes in South Korea and also supplies conversion kits for M47 and M48 tanks as well as spare parts for a wide range of tracked and wheeled military vehicles. Tracks currently manufactured are shown in the table.

Status: Production. In service with the South Korean Army and also exported.

Manufacturer: Lucky-Goldstar International Corporation, 537 Namdaemun-ro 5-ga, Chung-gu, Seoul, South Korea, CPO Box 1899. Telephone: 777-8096 Telex: K27266 Fax: 752-8258/9

Vehicle	Track model	No Per Unit
M47 tank	T84E1	172
M48 tank	T97E2	156
M60 tank	T142	156
M113 series	T130E1	127
M110/M107	T132E1	151
M109A2	T136	151

UNITED KINGDOM

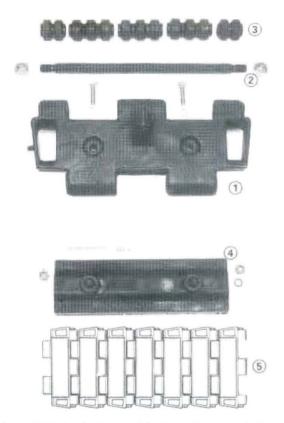
Blair Tracks

Description

The Defence Products Division of the Blair Group is involved in the design, development and production of track, running gear components and armoured castings. In addition to providing standard track the company also offers an individual design and manufacturing service.

Track refurbishment

George Blair, in co-operation with MAFUSA of Spain, is now offering incountry track refurbishment programmes to suit individual customer requirements. The in-country track refurbishment, according to the company, saves money and stockholdings and reduces dependency on other suppliers

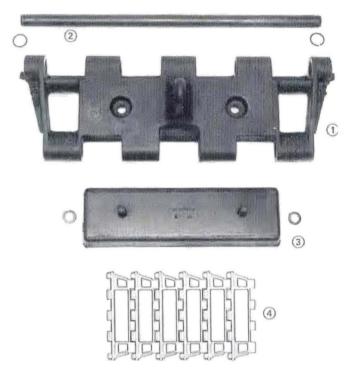


Warrior track link showing (1) track link (2) complete track pin (3) replaceable rubber bushes (4) complete track pad and (5) seven link wrap

in times of crisis. The company offer equipment for refurbishment of single or double pin track. Refurbishment includes breaking down wraps into individual links, removing all rubber components and material from links, cleaning and inspection of link body, rebushing, rebounding and repadding the link and finally reassembling links into wraps. They also offer automated and semi-automated equipment for all of these stages together with inspection equipment.

Other tank links

These include an improved track link for the M113 armoured personnel carrier and variants, MBT double pin track with rubber bushed pads, replaceable road path, rubber wheelpath and replaceable connectors.



Challenger 1 MBT track showing (1) track link (2) complete track pin (3) track pad and (4) six link wrap

There is also an M113 rubber bushed single pin track with a replaceable road pad, rubber bushes and rubber wheelpath.

For former Soviet vehicles Blair produces the BLR 724 all steel dry pin track for the PT-76 light amphibious tank, BLR 2132 all steel dry pin track for MBTs, BLR 2102 all steel rubber bushed track for MBTs and the BLR 2285 replaceable rubber padded and bushed track for MBTs.

A double pin track has also been designed for the British Challenger 2 MBT, with rubber bushed pins, replaceable road patch, rubber wheelpath and replaceable connectors. For the CVR(T) Scorpion series a rubber bushed single pin track is available with integral road pad, rubber bushes and a rubber wheelpath.

Running Gear

The company can also supply the following items of running gear for armoured fighting vehicles:

Vehicle To		Sprocket	Drive	Road	Idler	
100	llers	wheels	sprockets	wheels	wheels	
Challenger 1 ye		no	yes	yes	yes	
Chieftain no		yes	yes	yes	yes	
Centurion no		no	yes	yes	yes	
CET no		no	yes	yes	yes	
Scorpion no)	yes	yes	yes	yes	
FV432 no)	yes	yes	yes	yes	
Warrior)	yes	yes	no	no	
T-54/T-55/T-62/						
Type 59 no)	yes	yes	yes	yes	
PT-76 no)	yes	yes	по	yes	
T-34 no)	yes	yes	yes	yes	
M113 no		no	yes	yes	yes	
M41 no		yes	yes	no	yes	
M47 no		yes	yes	no	yes	
SPECIFICATIONS (track I	inks)					
Vehicle	Challenger 1	Chieftain	Centurion (steel)	Centurion (rubber)	Warrior	Scorpion
WIDTH	650 mm	609.6 mm	609.6 mm	552.45 mm	459 mm	425.45 mm
MEAN PITCH	165 mm	157 mm	139.95 mm	142.2 mm	152.4 mm	116.3 mm
TOTAL TANK TRACK						
WEIGHT	5363.88 kg	5040 kg	4006 kg	4482.76 kg	2648.8 kg	738.6 kg
TRACK WEIGHT PER		-				
METRE	176.676 kg	167.19 kg	132.517 kg	145.95 kg	103.456 kg	39.69 kg
NUMBER OF LINKS PER					A STATE OF THE STA	
TRACK	92 × 2	92 × 2	108 × 2	108 × 2	84 × 2	80 × 2
SINGLE TRACK LENGTH	15.18 m	15.072 m	15.115 m	15.358 m	12.8016 m	9.304 m
NUMBER OF RUBBER						
PADS/LINK	one	one	none	three	one	one
EXCHANGEABLE PADS	yes	yes	no	no	yes	no

Vehicle	Combat Engineer Tractor (CET)	FV432	M113
WIDTH	508 mm	355.6 m	381 mm
MEAN PITCH	152.4 mm	117 mm	152.6 mm
TOTAL TANK TRACK			
WEIGHT	2448 kg	1480 kg	1620 kg
TRACK WEIGHT PER	3		
METRE	100.4 kg	70.275 kg	70.77 kg
NUMBER OF LINKS F	PER	_	
TRACK	$76 \times 1, 77 \times 1$	90 × 2	64×2
SINGLE TRACK LEN	GTH 12.192 m	10.53 m	11.445 m
NUMBER OF RUBBE	R		
PADS/LINK	one	one	one
EXCHANGEABLE PA	DS yes	yes	yes

Status: All of the above tracks are produced as required. In service with the British Army and other undisclosed countries.

Manufacturer: George Blair Plc, Defence Products Division, Armond Carr Works, Tow Law, Durham DL13 4HH, UK.

Telephone: (0388) 730331 Telex: 58630 BLAIR G Fax: (0388) 731030

Catton Tracks

Description

Catton has been supplying tracks to the British Army as well as many overseas countries for many years and by 1988 production had passed over five million track links. In addition to supplying individual links and complete links, the company also supplies a wide range of ancillary equipment such as gun cradles, cupola hatch castings, idler wheels, periscope mountings, sprocket carriers, exhaust elbows and top roller brackets. The following is a summary of tracks currently manufactured by Catton:

Vehicle Type	Date Introduced	Quantity	Status
Challenger 1	1976	260 000+	production
Chieftain	1964	1 000 000+	production
Centurion*	1947	1 000 000+	production
CVR(T) series	1972	1 000 000+	production
Vickers Mk 3	1966	200 000+	production
FV432 series	1963	1 800 000+	production
T-34/85	1981	30 000+	production
			as required
T-54/55/59/69*	1977	140 000+	production
			as required
T-62	1981	65 000+	production
			as required
BMP-1	1981	30 000+	production
			as required
BTR-50PK/PT-76*	1981	60 000+	production
			as required
ATS-59	1981	15 000+	production
			as required
OT-62*	1981	60 000+	production
			as required
ZSU-23-4	1981	25 000+	production
			as required
Warrior	1986/87	n/av	production
CET	1986/87	n/av	production
M110/M107	1986/87	n/av	production
AMX-13	1991/92	n/av	production

^{*} Rubber and all-steel tracks available.

New products

Late in 1988 Catton and Company announced that it had developed, as a private venture, a new track link with a replaceable rubber pad which is a direct replacement for the existing former Soviet T-54/T-55 all steel track. The replaceable rubber pad is held in position by two bolts. The company has also developed to the prototype stage a new track for the PT-76 light amphibious tank, this being a bonded one-piece track. Both the new T-54/T-55 and PT-76 tracks are direct replacements for the existing former Soviet-designed tracks with no modifications required to the actual vehicle. The new tracks offer a number of advantages over the existing tracks including longer life, less damage to road surfaces and quieter operation.

Status: All of the above are produced as required. In service with the British Army and other undisclosed countries. Largest export customer to date has been Egypt.



Catton-produced T-62 track link



Catton-produced T-54/T-55 track link

Manufacturer: Catton and Company Limited, Defence Products Group, PO Box 28, Cross Green Approach, Leeds LS1 1JG, UK. Telephone: (0532) 496363 Telex: 55415 CATTON G Fax: (0532) 491376

Mondial Track System

Development/Description

In 1992 Mondial Defence Systems completed development of a new double pin track which can be installed on former Soviet MBTs, ARVs, CEVs and self-propelled artillery systems. This was developed in association with an unnamed US Army approved track manufacturer.

Production quantities have already been supplied to an undisclosed customer and installed on its vehicles.

The track conversion set comprises four sprocket rings which fit the sprocket hubs, a simple change taking less than one hour. The vehicle is then pulled onto the new track and connected with standard M series end connectors.

As well as being suitable for the T-54/T-55/T-62 style non-bogied system, it can also be used with the more recent T-64/T-80 fully tensioned track system. The set up for both systems requires the correct assembly of the eight link wraps which is carried out in the factory, although unit workshops can be supplied with a jig if required.

The company claim that former Soviet vehicles fitted with this new track have many advantages, including improved cross-country ride and mobility, smoother clutch take up, the vehicle is less prone to shed track on tight turns, does no damage to roads (as the track has rubber pads), up to 50 per cent increase in road speed, improved comfort for the crew, low hull noise as the track pin is no longer knocked back, easier maintenance, improved fuel consumption and reduced track damage.

Status: Production. In service with an undisclosed country.

Manufacturer: Mondial Defence Systems Limited, 12 Market Street, Poole, Dorset BH15 1NF, UK.

Telephone: (0202) 668661 Telex: 41327 VICTOR G Fax: (0202) 669755

UNITED STATES OF AMERICA

AAI Roller Chain Band Track

Development/Description

The Roller Chain Band Track has been developed by AAI under contract to the David Taylor Research Center, Marine Corps Program Office, Bethesda, Maryland, to provide a lighter and quieter track for medium weight combat vehicles when compared to existing block tracks.

The Roller Band Track provides a continuous rubber rolling surface for the roadwheels on the two inner bands. Ground contact for the roadwheels is through inner bands and rubber road pads attached to the crossmembers. The outer two bands provide additional tensile and ground contact footprint in soft soil conditions. The steel crossmember incorporates sprocket drive surfaces and centre guide for the roadwheels and the crossmember is the



Close-up of AAI developed Roller Chain Band Track from outside (left) and inside (right)

point at which the four bands are connected and is the lateral structural member for the track on uneven terrain.

Earlier testing of a 381 mm wide band track on a M113 series APC demonstrated significant improvements over the standard block track in the areas of reduced weight, less noise and vibration and reduction in rolling resistance. A 431 mm Roller Chain Band Track has been installed on the AAI-built Automative Test Rig (ATR) and the High Water Speed Technology Demonstrator (HWSTD). A 533 mm Roller Chain Band Track has been tested on a USMC AAV7A1 and on the AAI developed Propulsion System Demonstrator (PSD).

SPECIFICATIONS

TRACK	431 mm	533 mm
WEIGHT per 0.304 m	16.78 kg	22.22 kg
PITCH LENGTH	148 mm	170 mm
THICKNESS	68 mm	73 mm
TRACK COMPARISON		
TRACK	T130	Band Track
TOWING RESISTANCE		
at 32 km/h	474.9 kg	389.64 kg
ACCELERATION TIME		
to 48.28 km/h	32.7 s	23.7 s
VERTICAL VIBRATION		
(RMS G level) (at 32 km/h)	1.2	0.25
NOISE LEVEL (dB)		
at 32 km/h		
Crew compartment	120	108 to 112
Driver's compartment	122	114
The I was the second of the State St		

Status: Undergoing US Marine Corps trials.

Manufacturer: AAI Corporation, PO Box 126, Hunt Valley, Maryland 210030-0126, USA.

Telephone: (301) 666 1400 Telex: 8-7849 TWX: (710) 232 1800

FMC Track Shoes

Description

The Steel Products Division of FMC Corporation manufactures track shoes, torsion bars, road arm assemblies, idler wheels and similar components for armoured fighting vehicles. Track shoes are manufactured for the vehicles shown in the table.

Vehicle	Part Number	US National Stock Number
M113 (T130 track)	11646782	not applicable
,	11677988-6	2530-00-078-2908
M2/M3 (T157 track)	12295278	not applicable
,	12296918-1	2530-01-102-4728
	12296918-2	not applicable
	12296918-3	not applicable
	12296918-4	not applicable
	12296918-5	not applicable
AAV7A1	2584017	not applicable
	2584103-1	2530-00-191-8876
	2584103-2	2530-01-107-2920
	2584103-3	2530-00-191-8876
	2584103-4	2530-00-575-7194
M48/M60 (T142)	11645128	not applicable
,	11645125	2530-00-150-5897
M109 (T136)	10954046	not applicable
,/	10954051	not applicable
	1093437	not applicable
M107/M110	10934637	not applicable
	13211E9227	not applicable

New FMC Tracks

In addition to the previously mentioned AFV tracks, FMC Corporation, Steel Products Division, has recently introduced three new tracks, the T150, T154 and T158 and additional details of these are provided below.

T150 Track for M113 Series Vehicle

This track was developed by US Army Tank Automotive Command and FMC Steel Products Division for vehicles in the 12-20 ton (US) range. It is a forged steel double pin live track and is a replacement for the T130E1 track used on the M113 series of vehicles.

Key performance features and benefits of the T150 track have been summarised by FMC as:

Features	Benefits
Two induction hardened pins	Increases bushing area, improves durability by 300 per cent, reduces pin cracking through load distribution, provides ability to complete the mission after bushing failure
Integral forged shoe body	Optimal grain flow means greater durability and strength at minimum weight
75 per cent larger replaceable parts	Reduced footprint, improved traction and longer pad life
Roadwheel path backing rubber	Vibration and noise levels significantly lower, completely compatible with sophisticated electronic systems
Replaceable wide faced end connectors	No sprocket slot wear in track block for rebuild capability, reduced sprocket wear and increased sprocket life

SPECIFICATIONS

TRACK WIDTH	381 mm (variable by simple modification
	to end connector)
TRACK PITCH	152.4 mm
PIN DIAMETER	29 mm
PAD TYPE	replaceable
CENTRE GUIDE	integral
NUMBER OF PINS	2 (hollow)
PAD NUTS	capped
NUMBER OF PARTS	7
ROADWHEEL PATH	rubber
PITCHES PER VEHICLE	127
PITCH WEIGHT	10.39 kg
WEIGHT OF TRACK PER M11	3 1319 kg

T154 Track for M992 FAASV

This has also been developed by US Army Tank Automotive Command and FMC Steel Products Division and is a forged steel double pin track for tracked combat vehicles in the 28-40 tons (US) weight range. It has been tested on seven different vehicle types and is in production for the M992

Field Artillery Ammunition Support Vehicle (FAASV) where it has replaced the T136 track. Different track widths are available to suit different vehicle types including the M2/M3 Bradley family.

Key performance advantages of the T154 track when compared to the older T136 track have been summarised by FMC Steel Products Division

Features	Benefits
Two induction hardened pins	Increases bushing area and improves durability by 200 per cent
Integral forged shoe body	Optimal grain flow means greater durability and strength at minimum weight
44 per cent larger replaceable pads	Reduced ground pressure, improved traction, much longer pad life
Replaceable wide faced end connectors (clamp style)	Reduced sprocket wear and increased sprocket life ensures proper track bushing pre-load
SPECIFICATIONS	
TRACK WIDTH	381 mm (variable up to 533 mm by simple modification to end connector)
TRACK PITCH	152.4 mm
PIN DIAMETER	31.75 mm (hollow)
PAD TYPE	replaceable
OFNITHE OLUBE	take and

CENTRE GUIDE integral NUMBER OF PINS 2 (hollow) **END CONNECTOR** clamp type PAD NUTS capped ROADWHEEL PATH rubber NUMBER OF PARTS PITCHES PER VEHICLE 166 PITCH WEIGHT 13.7 kg TRACK WEIGHT PER VEHICLE (M109) 2273 kg

T158 Replaceable Pad Track

The T158 track shares the same configuration envelope, track/vehicle height and method of installation as the existing T156 track installed on the M1/M1A1/M1A2 MBTs.

It has triple the life of the existing T156 track, exceeds the US Army track durability criterion, has lower life cycle costs than the existing T156 track, can be installed on the M1 tank with no modifications to the vehicle and has no degradation in M1 performance.

Components of the T158 track are the rubberised track block, centre guide kit, end connector kit, rubberised pin and rubberised track pad. The track pad weighs 34.11 kg and is 635 mm wide.

Status: In production. In service with the US Army and many other countries.

Manufacturer: FMC Corporation, Steel Products Division, 2101 West 10th Street, Box 1030, Anniston, Alabama 36201, USA.

Telephone: (205) 237 2841 Telex: 6714994 Fax: (205) 235 9691

Advanced Track For Heavy Weight Class Vehicles

Development/Description

The T158LL and XT166 are advanced track systems being developed for the 45-70 ton (US) gross vehicle weight class of combat vehicles in the near term (1995).

Both of these track systems are 625 mm (25 in) wide and are double pin replaceable pad design configurations. In addition to being easy to maintain, they also offer increased durability with reduced weight through the use of computer-aided design analysis and optimisation.

The T158LL is an improved version of the current production Abrams MBT T158 forged steel track with weight reduction being the primary goal. It has a two piece shoe body, two bolt domed centre guide, clamp type (wedgeless) end connectors, replaceable roadwheel path rubber and is non-directional.

The XT166 is a hybrid design that is intended to capitalise on the best features of both single and double pin track design. It has a one piece shoe

body, integral centre guide, intermediate connectors without any wedge, bolt or nut components and is non-directional.

The first generation vehicle tested design was forged steel; however, the need for further weight reduction has necessitated the consideration of alternative materials and cast manufacturing options.

According to the developing agency, Tank Automotive Command, the benefits of the advanced track system include a reduction of up to 590 kg per vehicle in track weight, and increased track life (4800 to 9600 km durability), a 10 to 25 per cent reduction in life cycle costs and weight class vehicle commonality.

Developing agency: United States Army Tank Automotive Command, Warren, Michigan 48397-5000, USA.

Telephone: (313) 574 2675

Suspensions

FRANCE

Messier Suspension Systems

Development

Messier Auto Industrie, a division of Lucas France SA, has been involved in the design, development and production of suspension systems for wheeled armoured vehicles for many years and, more recently, tracked armoured vehicles as well.

Lever Operated Dampers

Since 1948 Messier Auto Industrie has been developing double action, lever operated hydraulic dampers which can withstand high damping torque as well as giving a high degree of reliability. These dampers are specified for members of the AMX-13 light tank family, AMX-30 MBT family and the AMX-10P family of tracked vehicles. They have also been fitted to Alvis Scorpion and Stormer vehicles. These are now being retrofitted to British Army Scorpions as they are overhauled.

SPECIFICATIONS (AMX-10P damper)

MAX DAMPING MOMENT 2000 mdaN WEIGHT WITH LEVER 22 kg

Rotary Dampers and Bump Stops

Messier Auto Industrie has developed rotary dampers capable of withstanding very high torques. These, along with bump stops and torsion bars, form a complete suspension package.

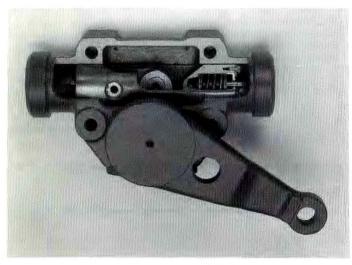
Hydro-pneumatic Suspension Systems for Wheeled Vehicles

The company started developing these in the 1960s and they are now fitted as standard on the Giat Industries AMX-10RC (6 x 6) armoured car, the Spanish BMR-600 (6 \times 6) infantry fighting vehicle and the VEC Cavalry Scout Vehicle (6 \times 6), the Thomson-CSF Crotale surface-to-air missile system and the prototype of the Renault VBL (4 × 4) light armoured vehicle. The Renault VBL, however, never entered production as the competition was won by the Panhard VBL design.

More recently they have been installed on the Italian FIAT/OTO Melara (8 × 8) B1 tank destroyer which is now in production for the Italian Army.

According to Messier, comparative tests of identical vehicles fitted with standard suspension systems and hydro-pneumatic systems have demonstrated that the latter have a marked decrease in vertical acceleration. This leads to an increase in the mobility of the vehicle, improved ride for the crew, lighter weight of suspension components, greater reliability and reduced maintenance requirements.

The six hydro-pneumatic suspension jacks on the AMX-10RC act simultaneously as a pneumatic suspension spring and as shock absorbers. The driver can alter the ground clearance of the AMX-10RC from 0.2 to 0.6 m by a single lever and can also tilt the vehicle left or right or back to front



Messier Auto Industrie rotary damper for AMX-10P

SPECIFICATIONS (AMX-10RC unit) MAX STRESS ON EACH

SUSPENSION JACK

4800 daN (static) 15 000 daN (dynamic)

MAX SUSPENSION

TRAVEL OPERATIONAL PRESSURE 217 mm 95 bar (static) 300 bar (dynamic)

WEIGHT PER UNIT

Each BMR-600 or VEC has six hydro-pneumatic suspension units, each of which act as pneumatic suspension springs, shock absorbers and stub axle spindles. The driver, using a single lever, can alter the ground clearance without leaving his seat.

SPECIFICATIONS (BMR-600 Unit)

MAX STRESS ON EACH SUSPENSION UNIT

2500 daN (static) 10 000 daN (dynamic) MAX CYLINDER STROKE 270 mm OPERATIONAL PRESSURE 40 bar (static)

160 bar (dynamic)

Hydro-pneumatic Suspension Systems for Tracked

The company has also supplied prototype hydro-pneumatic suspension systems for installation on some of the Leclerc testbed vehicles. An electronic and hydraulic regulator fitted to the hydrogas suspension system controls the ride angle and ground clearance of the vehicle.

Rotary Hydraulic Shock Absorber for 30 to 50 Tonne Tracked AFV

Messier has recently built prototypes of a rotary hydraulic shock absorber that has been designed for installation in the holes left in an AFV hull by the removal of the torsion bars, thus saving valuable space in the hull. Messier Auto Industrie suggests four or eight are used per vehicle, for example, installed on the first and last roadwheel stations either side or the first two and last two road wheels each side.

SPECIFICATIONS

23 kg WEIGHT

MAX DAMPING

MOMENT (FOR ANGULAR SPEED BETWEEN 2 AND

24 RAD/S) 10 000 Nm-20 000 Nm

Air-hydraulic Suspension Unit

This has been developed to the prototype stage with each road wheel having one air-hydraulic suspension unit which carries out the role of a pneumatic suspension spring and a shock absorber. The suspension is fed with pressurised oil via the vehicle's hydraulic powerpack. By operating a control placed at the driver's station it is possible to vary the ground clearance. A built-in automatic device ensures locking of the suspension in position in the event of damage to the feed circuit.

SPECIFICATIONS (air-hydraulic unit) MASS ASSIGNED TO EACH

ROAD WHEEL 4000 kg

DYNAMIC LOAD PER ROAD WHEEL 160 000 N LENGTH OF ARM 0.4 m

VERTICAL STROKE AT ROAD WHEEL

-0.15 m under extension +0.35 m under compression 0.5 m total stroke

STIFFNESS FORCE AT

ROAD WHEEL 3000 daN WEIGHT OF UNIT 250 kg

In-arm Integrated Hydro-pneumatic Suspension Unit

This is an integral supension system representing an alternative to the twin cylinder unit. A particular feature is the integration of the springing and damping functions within the arm which, according to Messier, makes for a better and lighter installation. In addition, the hull of the vehicle does not require any adaption to permit its installation.

SPECIFICATIONS

STATIC LOAD ON ROAD

WHEEL 3000 to 4000 kg
MAX DYNAMIC LOAD 20 tonnes

TRANSVERSAL LOAD TO

ROAD WHEEL 8 tonnes

MAX VERTICAL SPEED

OF ROAD WHEEL 20 m/s
BUMP STROKE 300 mm
REBOUND STROKE 100 mm
ROAD WHEEL GYRATION

 RADIUS
 415 mm

 WEIGHT
 180 kg

On-arm Hydro-pneumatic Suspension Unit

Suspension on the arm is possible by means of a hydro-pneumatic strut mounted parallel to the arm. The strut performs both springing and damping functions and is connected at one end of the hull to the other end of the arm. This is suitable for vehicles in the 12 to 18 tonnes range.

3.5 tonnes

SPECIFICATIONS (on-arm unit)

 STATIC LOAD ON ROAD

 WHEEL
 0.8 to 2 tonnes

 MAX DYNAMIC LOAD
 3 to 6.5 tonnes

TRANSVERSAL LOAD TO ROAD WHEEL

MAX DAMPING LOAD
ON ROAD WHEEL 3 tonnes

ON ROAD WHEEL MAX VERTICAL SPEED

 OF ROAD WHEEL
 10 m/s

 BUMP STROKE
 150 mm

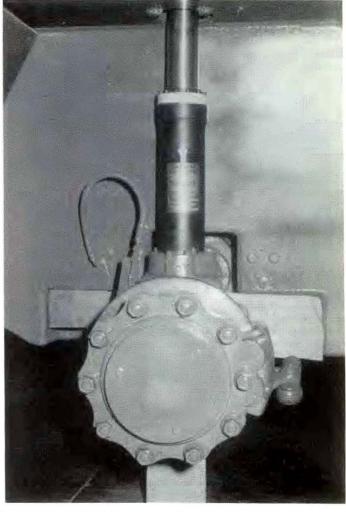
 REBOUND STROKE
 100 mm

ROAD WHEEL GYRATION
RADIUS 360 mm
WEIGHT 80 kg

Manufacturer: Messier Auto Industrie, 6 rue du Moulin par le Bas, Champlan, BP 137, 91163 Longjumeau Cedex, France.

Telephone: (1) 69 09 01 58 Telex: 604 455 MESAIND

Fax: (1) 69 09 66 21



Messier Auto Industrie hydro-pneumatic unit fitted on a Spanish BMR-600 (6×6) IFV

SAMM Suspension Systems

Development/Description

SAMM is developing a wide range of suspension systems for tracked and wheeled armoured vehicles. In 1987 the company delivered the first twin hydro-pneumatic suspension systems for prototypes of the Leclerc MBT and the first prototypes of the new linear suspension systems for the Thomson-CSF Crotale surface-to-air missile launcher. In addition to designing suspension systems for current tracked and wheeled vehicles, SAMM is also developing systems that can replace current torsion bar suspension systems.

In addition to the suspensions described below, SAMM also designed and produced the hydraulic suspension system for the Giat Industries 155 mm TR towed artillery system now in service with the French Army.

Linear hydro-pneumatic suspension for light armoured vehicles

These have been designed by SAMM for installation on light and medium armoured vehicles weighing under 25 tonnes and have been installed on a number of different tracked and wheeled armoured vehicles.

The hydro-pneumatic suspension element carries out, under the form of a compact linear unit, the elasticity and damping functions of a suspension. The elastic element consists of a gas which is compressed while oil viscosity is used to damp the motions. If required, the unit can perform additional functions such as attitude correction and ground clearance variations.

Different arrangements can be provided to meet specific customer requests, for example, on-arm suspension type for retrofitting to medium tracked vehicles and MacPherson suspension types for 4 x 4 and 8 x 8 wheeled vehicles.



SAMM twin cylinder hydro-pneumatic suspension system for 50 tonne tanks

SPECIFICATIONS (Typical) WEIGHT

supported per wheel station 1900 kg
TOTAL VERTICAL
displacement of road wheel 350 mm

 displacement of road wheel
 350 mm

 DAMPING FACTOR
 0.4

 MAX PRESSURE
 420 bar

 WEIGHT OF ELEMENT
 25 kg



SAMM suspension for light armoured vehicle

Twin-cylinder hydro-pneumatic suspension system for tanks

This has been designed by SAMM for installation on MBTs in the 50 tonne class and the unit can ensure additional functions such as attitude and ground clearance variation. In addition to offering this for installation on new vehicles, SAMM also proposes that this could be used as a replacement for torsion bars on existing vehicles.

SPECIFICATIONS

VERTICAL TRAVEL rebound jounce total travel VERTICAL LOAD (NOMINAL) rated stress iounce stress PRESSURES (NOMINAL)

OUTSIDE TEMPERATURE RANGE

NATURAL FREQUENCY

WEIGHT

-125 mm

+300 mm 425 mm

45 000 daN 22 000 daN

225 bar 900 bar

-40°C to +70°C

1 Hz for a 4 tonne sprung weight

250 kg



MacPherson type hydro-pneumatic suspension element

MacPherson Hydro-pneumatic Suspension

This has been designed by SAMM for installation on 4×4 and 6×6 wheeled armoured vehicles and is currently undergoing trials.

The unit carries out the elasticity and damping functions of a suspension and guides the motion of the wheel. The elastic element consists of a gas which is compressed with oil flowing through a restrictor being used to damp the motions. In addition, the unit can receive additional functions such as attitude correction and ground clearance variation.

SPECIFICATIONS

STATIC FORCE PER ELEMENT 2500 daN MAX FORCE 11 000 daN STATIC PRESSURE 50 bar MAX PRESSURE 220 bar TOTAL STROKE OF ELEMENT 280 mm

Status: In mass production for new Leclerc MBT for the French Army. Onarm type is fitted on the Giat Mecanique Creusot-Loire MARS-15 family of light armoured vehicles. In evaluation for MacPherson type on a 4 x 4 test bed. On-arm is also suitable for AMX-13 light AFV retrofit.

Manufacturer: Société d'Applications des Machines Motrices (SAMM) Chemin de la Malmaison, F-91570 - Bièvres, France. Telephone: 33 (1) 69 35 80 00 Telex: 933 - 1 69 41 15 72

Fax: 33 (1) 69 35 81 98

GERMANY

Krauss-Maffei Hydraulic Bump Stops

Development/Description

For many years Krauss-Maffei has been carrying out intensive research in the field of suspension improvement, with one of the major areas being the replacement of common bump stops. The Leopard 2 is fitted with hydraulic bump stops as standard equipment.

According to Krauss-Maffei, trials showed that the installation of hydraulic bump stops not only significantly improved the performance and reliability of the suspension system but also improved crew comfort and reduced the impact of shock on the optronic and electronic equipment installed in the vehicle.

Krauss-Maffei has now designed a whole series of hydraulic bump stops that can be quickly fitted to a variety of wheeled or tracked armoured vehicles as well as passenger cars



Selection of the wide range of hydraulic bump stops made by Krauss-Maffei for armoured vehicles

Germany has tested a Leopard 1 retrofitted with hydraulic bump stops and Australia has retrofitted its Leopard 1s with hydraulic bump stops, since when no further roadwheel arm distortion has been reported. In addition, the hydraulic bump stops are in service on Leopard 1 MBTs of the

Trials have also been carried out on other vehicles, including the Swiss Pz 68, which demonstrated not only much improved gun stabilisation but a reduction in the load of almost 40 per cent on the running gear.

GLS, a subsidiary of Krauss-Maffei, offers a number of retrofit packages for armoured vehicles, including the installation of hydraulic bump stops. For example, on the M48 series, hydraulic bump stops are mounted at all wheel stations with no modifications to the hull structure, while new telescopic shock absorbers are fitted at roadwheel positions 1, 2 and 6. The existing torsion bars are replaced by new torsion bars made of the same material as those installed in the Leopard 1 MBT.

For the M41, a prototype of which has already been trialled overseas, suspension improvements include improved torsion bars, dual action telescopic hydraulic shock absorbers and hydraulic bump stops for the roadwheel arms.

For the AMX-13, GLS offers a number of improvements including a new connector type track, modified sprockets and final drive, new roadwheels and idler (from M113), modified suspension arms, modified existing track return rollers, dual action hydraulic telescopic shock absorbers on first, second, fourth and fifth roadwheels and installation of Krauss-Maffei hydraulic bump stops. New torsion bars can also be installed if required.

Krauss-Maffei hydraulic bump stops are maintenance-free and are easy to retrofit in the same mounting position as the former mechanical bump stop. The life expectancy of hydraulic bump stops is considerably higher compared to the one for mechanical dampers.

The main features of these hydraulic bump stops have been summarised by Krauss-Maffei as follows:

hard impacts on the chassis are avoided by absorbing surplus energy which cannot be absorbed by the suspension system

- (2) the anticipated characteristics of the suspension system are maintained since the hydraulic bump stop acts only within the second half of the positive roadwheel arm travel
- (3) the damping force is matched to impact velocity

Status: In production.

Manufacturer: Krauss-Maffei Wehrtechnik GmbH, Krauss-Maffei

Strasse 2, 8000 Munich 50, Federal Republic of Germany.

Telephone: (089) 88 99 0 Telex: 5 23 163 31 Fax: (089) 8 12 01 90

- (4) there is a high workload capacity in relation to weight and dimensions
- (5) the highest possible workload capacity is ensured, with reaction forces kept at a minimum, since an almost rectangular damping characteristic has been chosen
- (6) a piston of spherical shape and a flexible guiding and sealing system are used. The piston rod tilts, thus following the circular movement of the roadwheel arm
- (7) the bump stop absorbs the energy instead of accumulating it.

SPECIFICATIONS TYPE OF BUMP	VEHICLE	WORKING	BLOCK-LENGTH	WEIGHT	WORKING LOAD	IMPACT SPEED
TIPE OF BOMP	VEINOLE	STROKE	mm	kg	CAPACITY	m/s
		mm		ng .	Nm	5
70 × 56V	Leopard 1	56	140	6.2	15 750	1.25
70 × 56	Leopard 1 and M48	56	140	6.2	7350	1.25
70 × 56	Shark 8 × 8	56	140	6.2	6200	2.4
70 × 70V	Leopard 1 reinforced	70	152	6.9	19 680	1.4
70 × 70	Leopard 1	70	152	6.9	9600	1.4
70 × 70	Puma, M44 and Tornado	70	152	6.9	9190	1.4
70×70	AMX-30	70	152	6.9	11 125	2.5
70 × 85	Marder 1	85	180	8.4	9410	1.4
70 × 85	BPz 85	85	180	8.4	15 700	2.8
70 × 85	PzH 2000	85	180	8.4	20 300	2.2
70 × 140	Leopard 2	140	250	11.2	15 700	2.8
70 × 140	Pz 68	140	250	11.2	14 420	5.24
70 × 140	Taurus	140	250	11.2	22 660	2.6
60×60	MAN 8 × 8 truck	60	130	4.0	7000	1.5
60 × 60	M113	60	130	4.0	6490	1.25
60 × 60	T-54/T-55	60	130	4.0	9400	2.3
60 × 60	KSPz 90 and M41	60	130	4.0	9200	1.4
60 × 100	AMX-13 and Scorpion	100	178	5.0	7800	2.8

ISRAEL

SHL Hydraulic Bumpers

Development/Description

Many MBTs are fitted with suspension systems that incorporate spring bumpers that are designed to absorb buggy arm velocity and to stop motion at the final stage.

In most tanks, however, the bumper consists of a high rate steel spring which bottoms under high velocities. The resultant uncontrolled high forces are then transferred to the hull of the tank and so have an effect on performance.

Conventional steel spring bumpers transfer high dynamic loads and G-factors to the crew and its systems, and the driver has to reduce speed in order not to injure the crew or damage the vehicle.

SHL has developed a hydraulic bumper that replaces conventional spring bumpers. This consists of a cylinder piston assembly that absorbs high energies in order to improve tank performance. When the road wheel arm hits the piston it moves, forcing the oil through a series of orifices, a process that causes the bumper effectively to absorb the energy and stop the motion.

According to SHL, its hydraulic bumper significantly reduces the G-factors for the same high arm velocities, enabling a more comfortable speed over rough terrain at higher speeds.

The hydraulic bumper can be adjusted according to customer specifications for different working conditions, different armoured vehicles and different terrain profiles.

Comparison of bumper/spring for M48/M60 MBT SHL Bumper

t
.3 kJ
il
0 mm

Spring

Note: In addition to manufacturing hydraulic bumpers for MBTs, SHL also manufactures hydraulic shock absorbers for armoured vehicles and gun control equipment including the elevating mechanism, add-on stabilisation system, gunners control assembly, deck clearance valves, hydraulic valve assembly and the complete hydraulic power pack for the turret. Details of SHT turret system upgrades are given in the Weapon Control and Stabilisation Systems section.

Status: Production. In service with the Israeli Army.

Manufacturer: SHL (Servo Hydraulics Lod), PO Box 190, IL-71101 Lod, Israel.

Telephone: (972) 8-222651 Telex: 371120 SHLD IL

Fax: (972) 8-222792

NETHERLANDS

KONI Hydraulic Shock Absorbers

Development/Description

For many years KONI has been supplying hydraulic shock absorbers for tracked and wheeled armoured fighting vehicles as well as trucks for both the home and export markets.

These include the German Spähpanzer Luchs (8×8) reconnaissance vehicle, the Timoney/BDX APC, MOWAG Piranha family of 8×8 , 6×6 and 4×4 vehicles, BMF-built Armoured Infantry Fighting Vehicles (AIFV) and

M113A1-B series APCs for the Belgian Army and Dutch-built Armoured Infantry Fighting Vehicles (YPR-765).

In addition, KONI has developed a special steering damper to overcome steering problems such as spontaneous tendencies of shimmy and wheel flutter. The steering damper only functions over a small stroke on both sides of a neutral position and, as a result, steering will not be affected when cornering and the wheels will return to straight forward position without any impact of the steering damper.

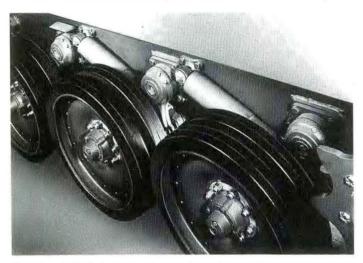
For the M113/AIFV series of full tracked vehicles, KONI has developed

new shock absorbers that are overrated in damping capacity and the special design allows perfect functioning in the horizontal position.

Kinetic energy, which is converted into thermal energy in the field, requires characteristics with high damping forces and, therefore, the shock absorber must be able to function under extremely high temperatures.

Extensive test programmes indicated that high piston speeds and enormous dynamic loads occur. In order to press the wheels as constantly as possible against the tracks and thus minimise wear and the derailing effect of the vehicles track, a degressive damping characteristic was chosen.

In order to ensure a good performance of the damper to temperatures of about +190°C, attention has been paid to the clearance between the piston



Close-up of KONI shock absorbers on M113A1-B APC

and the cylinder wall. In order to control this clearance, pistons and working cylinders are matched and an additional grinding operation is performed after piston to piston rod assembly.

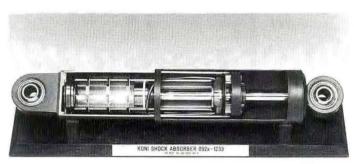
Special PTFE piston rings ensure a perfect guiding and sealing function of the piston and the same material has been applied in the piston rod guide.

The use of high class materials ensures that the shock absorber can resist the dynamic loads that occur under severe operational conditions. Extra attention is also paid to the oil and gas seals because of the high temperature. Viton spring loaded multiple lip seals and a special oil with additives are applied.

Status: In production. In service with Belgian, Netherlands and other armed forces.

Manufacturer: KONI BV, Postbus 1014, 3260 AA oud-Beyerland,

Telephone: 01860-12500 Telex: 21181



Cutaway of KONI absorber as used on M113A1-B

UNITED KINGDOM

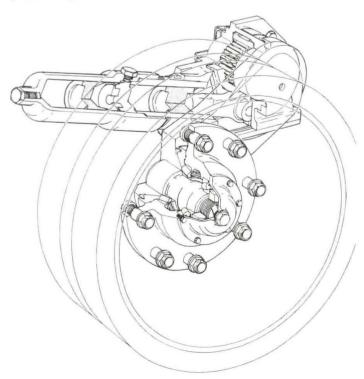
Air-Log Limited Running Gear Systems

Development

Air-Log Ltd (which incorporates Laser Engineering Development and Oceonics Vehicle Technology) is involved in the design, development and production of running gear systems for armoured vehicles.

Air-Log engineers designed and developed the hydro-pneumatic suspension system for the Challenger 1 MBT in conjunction with the Royal Armament Research and Development Establishment (RARDE), with production for Challenger 1 being undertaken by Royal Ordnance Factory Leeds (now Vickers Defence Systems, Leeds).

The company specialises in hydro-pneumatic suspension systems which combine the unique proven advantages of a gas spring with an integral hydraulic damper.



Schematic diagram of Air-Log hydro-gas suspension unit for the 155 mm AS90 self-propelled artillery system

Hydro-gas

The design principle of the hydro-gas unit is as follows: as the roadwheel rises the axle arm is lifted and this rotates the crank which moves the piston via the con rod; the piston displaces oil through the damper valve and moves the separator piston; this causes the gas to compress which produces the spring force.

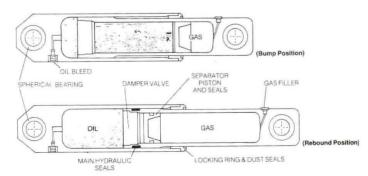
Most springs have a linear spring rate, for example torsion bar, coil springs and rubber. Gas has a progressive rate which increases, depending on how fast it is compressed. A gas spring suspension will, therefore, result in a softer rate around the static position (a soft fluid ride over normal terrain) and a stiffer rate near full deflection (which prevents the suspension in the majority of cases from travelling to bump).

The seals used have been developed over 10 years and can operate up to 200°C and 1000 bar (15 000 PSI), and a rubbing speed in excess of

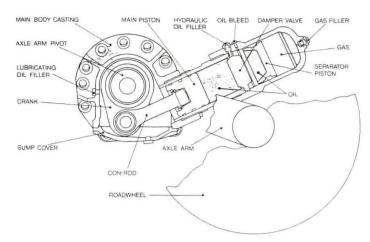
Air-Log has also developed a unique hydraulic damping relief valve which is now patented. The actual damping force is very close to the ideal curve and this results in high damper performance but with minimum heat generation. The Air-Log damper achieves this by using a special arrangement of disc springs and control orifices.

The Challenger 1 hydro-gas unit is attached to the hull with 11 high tensile bolts; no other fixing arrangements are required.

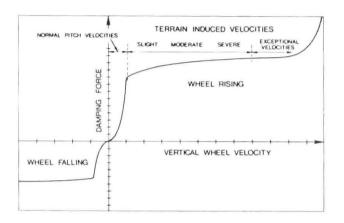
As each hydro-gas unit is totally independent, servicing any one wheel only affects that particular unit, unlike bogie arrangement where corresponding or opposite wheel stations are affected. Additional oil and gas pressure can be added whilst the unit is in situ, this being achieved by using the servicing module which is trolley- or Land Rover-mounted.



Cutaway drawing of typical Air-Log MBT hydrostrut with bump position (top) and rebound position (bottom)



Main components of Air-Log hydro-pneumatic unit for armoured vehicles



Typical damping characteristic of Air-Log hydro-pneumatic suspension

Main advantages of the hydro-pneumatic suspension system can be summarised

- (1) as the system is external there is more space inside the vehicle; on an MBT this would be a saving of 0.65 m3 over an equivalent torsion bar system. This allows the vehicle to have a lower silhouette. The overall weight of the hydro-pneumatic suspension is lighter than a comparable torsion bar system
- (2) cross-country performance of the vehicle is improved, giving greater comfort to the crew and allowing higher cross-country speeds.
- (3) the gun platform is more stable since there is less pitching and better absorption of recoil forces. According to Air-Log there is a notable increase in gun platform stability in Challenger 1 over conventionally sprung vehicles of a similar weight.
- (4) hydro-pneumatic suspension units can also be replaced in the field and the hull interior is not cluttered up with torsion bars.
- (5) if the weight of the vehicle increases, for example, due to the installation of more armour to cope with an increased threat, gas pressure can be adjusted to accept the increasing vehicle weight.
- (6) sensitive equipment inside the vehicle is subjected to lower acceleration levels which result in reduced shock loads and thereby increase equipment reliability

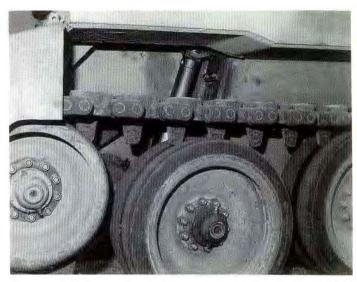
In addition to designing the hydro-pneumatic suspension system for the Challenger 1 MBT, Air-Log designed the complete running gear package, including a second generation hydro-gas suspension unit for the Vickers Shipbuilding and Engineering AS90 155 mm self-propelled artillery system which was first shown in 1986.

In mid-1989 the British Army selected the AS90 as its future 155 mm selfpropelled artillery system and placed an order with Vickers Shipbuilding and Engineering for the supply of 179 systems valued at £300 million with an option on a further 50 systems. First production AS90s were completed in 1992

Early in 1990 Air-Log announced that it had been awarded the contract by Vickers Shipbuilding and Engineering Limited to supply the complete running gear for the AS90 with a total value in excess of £16 million.

Air-Log has undertaken responsibility for the design, manufacture and programme management of the complete running gear package that includes an advanced Air-Log hydro-pneumatic suspension unit, German Diehl double pin track and sprockets, GLS top rollers and roadwheels and Air-Log designed and manufactured idler gear.

The AS90 has six hydro-gas wheel stations per side, all of which have integral hydraulic damping. The hydro-gas units have a low maintenance



Close-up of Air-Log tandem hydrostrut on rear station of 155 mm M109 series self-propelled howitzer

characteristic. The crew can vary the gas pressures of each unit although the hydraulic damping and bearing oil are sealed for the life of the unit.

The Diehl track is the Type 640, of the double pin rubber-bushed type. which has a track life of 5 to 6 times that of the normal steel pin track used by the British Army. The sprockets also come from Diehl. The roadwheels are from the Leopard 2 while the top rollers are from the Leopard 1

The Air-Log idler assembly incorporates an advanced hydraulic track tensioner with overload protection that allows the idler wheel to retract if excessive track tension is built up.

Hydrostrut

The hydrostrut system is a telescopic arrangement of hydro-gas, originally designed as a retrofit suspension for vehicles such as Chieftain and Centurion, but now suitable for applications on both new and upgraded vehicles. It offers the advantages of hydro-pneumatic suspension but in a small volume

The working principle is very similar to the hydro-gas system. An axle arm transmits the wheel movement to the hydrostrut and, as the outer cylinder moves over the inner, oil is forced through the damper and then displaces the separator piston subsequently compressing the gas.

Hydrostrut has been tested by the Swedish Army on a Centurion MBT, where it gave the vehicle a significant increase in cross-country performance.

The hydrostrut has also been evaluated by the British Army on a Chieftain MBT, Chieftain armoured repair and recovery vehicle and a Chieftain AVLB

A minimum of modification is required to fit the system to the vehicle; this can be undertaken in field workshops using basic tools and equipment.

Tandem Hydrostrut

This private venture development was announced in 1988 and is aimed at the AFV retrofit market where conventional torsion bar and hydraulic dampers are incorporated such as the M109 and M41.

Previous suspension retrofit options have been limited to either torsion bar and damper upgrades or full conversion to an alternative suspension geometry. Improvements to the torsion bar and damper are performance limited and usually result in over-stiff suspension around the static ride height.

Tandem Hydrostrut involves replacing the conventional telescopic damper with a combined gas spring and hydraulic damper unit. The torsion bar remains to provide the primary springing. The option to improve or modify the damping characteristic with a lock-out device is available

The increase in spring force can be tailored to suit the vehicle requirement, compensating for increase in weight due to improvements in armour protection and so on.

The main advantage claimed by Air-Log is that the resultant spring curve is progressive rather than the linear relationship of a torsion bar and ideally suited to high cross-country mobility. In addition, damper performance can also be improved to suit the specific vehicle requirement.

Trials already carried out in the USA on the BMY/RO 155 mm M109TX self-propelled howitzer have already demonstrated a marked improvement in gun platform stability as well as cross-country mobility. In the M109 solution, the existing front and rear dampers are replaced with Tandem Hydrostrut. No hull modification is necessary to install the units and the change from the original system to Tandem Hydrostrut can be accomplished in 30 man hours using existing equipment.

The Air-Log Tandem Hydrostrut has been tested on the US Army's Human Factors Howitzer Test Bed (HFHTB), an M109 155 mm selfpropelled artillery demonstrator at Aberdeen Proving Ground, USA.

SPECIFICATIONS (hydro-pneum	natic suspension unit	s)
TYPE	Challenger 1	AS90
STATIC WHEEL LOAD	5 tonnes	3.5 tonnes
AXLE ARM LENGTH	500 mm	450 mm
VERTICAL WHEEL TRAVEL	500 mm	400 mm
WEIGHT, LESS HUB	285 kg	175 kg
AMBIENT TEMPERATURE		
RANGE	-40 to +50°C	-40 to +50°C
MAX WHEEL FORCE	30 tonnes	20 tonnes

SPECIFICATIONS (typical	hydrostrut install	lations)	
VEHICLE	Centurion	M109	Chieftain
ORIGINAL VEHICLE			
WEIGHT	48 tonnes	24.7 tonnes	52 tonnes
GROWTH VEHICLE			
WEIGHT	59 tonnes	29.5 tonnes	62 tonnes
APPLICATION	complete	tandem strut	complete
	replacement	supplementing	replacement
		existing	
		suspension	

VEHICLE	Centurion	M109	Chieftain
WHEEL TRAVEL (mm)	-50/+200	-86/+178	-65/+215
STATIC WHEEL FORCE	43 kN	4.2 kN	46 kN
BUMP WHEEL FORCE	215 kN	59 kN	230 kN

Future suspension systems

Air-Log is currently looking at a number of other types of hydro-pneumatic suspension systems including: lock-out systems that allow the suspension to be locked from inside the vehicle for engineering activities; adjustable load and adjustable height systems that enable the vehicle attitude to be altered; smaller and more compact units; coplanar systems which give all the benefits that hydro-pneumatic suspension offers but in a more narrow volume, for example, in-arm suspension units.

With the introduction of active damping, sensors and control systems will automatically adjust the suspension damping rate to give the optimum ride.

Manufacturer: Air-Log Limited, North Lane, Aldershot, Hampshire GU12 4QH, UK.

Telephone: (0252) 24411 Telex: 858460 Fax: (0252) 333790

Dunlop Suspension Systems

Development

The Dunloride hydro-pneumatic suspension systems are the result of progressive development undertaken since the 1970s. Dunlop was one of the three original companies, the other two being Dowty and the then Laser Engineering, who were awarded development contracts by the Royal Armament Research and Development Establishment (Chertsey) in 1973 for the hydro-pneumatic suspension system for the Iranian Shir 2 MBT which subsequently entered service with the British Army as the Challenger 1.

Since then Dunlop has continued with the design, development and manufacture of a complete range of single cylinder hydro-pneumatic units in which the spring is separated from the damping fluid by a separator piston.

This range of suspension units now covers vehicles weighing from 10 to 60 tonnes and, according to Dunlop, offers the following advantages: maximisation of available engine power; greater off-road mobility; improved weapon system accuracy and reliability; reduced crew fatigue; overload capability; improved track retention and greater reliability; and ease of maintenance.

The Dunlop suspension systems now fall into three categories: Dunloride and Dunlostrut for tracked vehicles and Dunlostrut for wheeled vehicles. A brief outline and specifications for all three system types are given below.

Dunloride

The Dunloride system was originally developed in the early 1970s and has continued since then. It has been selected by ENGESA of Brazil for its EE-T1 Osorio MBT. The Dunloride is a self-contained unit including a single cylinder gas spring and hydraulic damper with road arm. It is available for a complete range of weight classifications ranging from 20 to 60 tonnes. As of early 1993 the EE-T1 had yet to enter production.

SPECIFICATIONS			
Weight class	20-30 tonnes	30-40 tonnes	40-60 tonnes
Wheel load (static)	16.35 kN	32.7 kN	49.05 kN
Wheel load (max)	75.58 kN	142.4 kN	220.7 kN
Wheel load (max			
side at bump)	32.7 kN	65.4 kN	98.1 kN
Vertical wheel displacement			
(static to bump)	330 mm	330 mm	350 mm
Vertical wheel displacement			
(static to rebound)	100 mm	70 mm	100 mm
Static internal			
pressure	6.87 N/mm ²	7.59 N/mm ²	7.69 N/mm ²
Max working			
pressure	48.26 N/mm ²	56.91 N/mm ²	57.25 N/mm ²
Unit weight	136 kg	200 kg	250 kg

Note: All above have an ambient operating temperature range from -40° to $+60^{\circ}$ C with the pneumatic medium being Nitrogen - white spot grade

Dunlostrut for tracked vehicles

This was originally developed to meet the requirements of the retrofit market where, in some cases, there is insufficient space in which to install a Dunloride unit. Such a case was the AMX-13 light tank. Dunlop has designed and developed a unit for this application which is now in production for Singapore and Giat Mecanique Creusot Loire of France as part of their retrofit packages. According to Dunlop it is now being considered for fitment on a number of programmes ranging from light tanks, armoured personnel carriers to MBTs.

It is a single cylinder, linear hydro-pneumatic suspension unit and combines a Nitrogen gas spring and hydraulic damper in a cylinder lying above and parallel to the road arm.

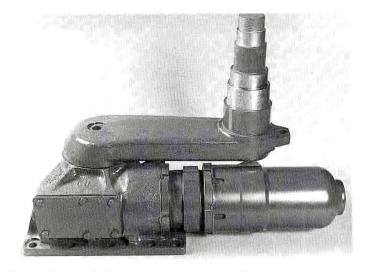
SPECIFICATIONS (for AMX-13 application)

SPECIFICATIONS (for AMX-13 applicati	on)
Wheel load (static)	15 kN
Wheel load (max)	67.5 kN
Wheel load (max side at bump)	30 kN
Vertical wheel displacement	
(static to bump)	275 mm
Vertical wheel displacement	
(static to rebound)	100 mm
Static internal pressure	7.14 N/mm ²
Max working pressure	34.9 N/mm ²
Unit weight	17.2 kg
Operating ambient temperature range	-40° to +60°C
Pneumatic medium	Nitrogen - white spot grade

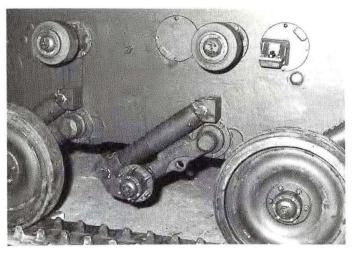
SPECIFICATIONS

SPECIFICATIONS			
Weight class	20-30 tonnes	30-40 tonnes	40-60 tonnes
Wheel load (static)	22.67 kN	32.44 kN	41.5 kN
Wheel load (max)	102 kN	146 kN	186.75 kN
Wheel load (max			
side at bump)	45.34 kN	64.88 kN	83 kN
Vertical wheel displacement			
(static to bump)	330 mm	330 mm	330 mm
Vertical wheel displacement			
(static to rebound)	100 mm	100 mm	100 mm
Static internal			
pressure	8.11 N/mm ²	6.38 N/mm ²	7.31 N/mm ²
Max working			
pressure	34.49 N/mm ²	32.35 N/mm ²	33.73 N/mm ²
Unit weight	23.58 kg	35 kg	41 kg

Note: All have an ambient temperature range of -40° to $+60^{\circ}$ C with pneumatic medium being Nitrogen - white spot grade



Typical Dunloride hydro-pneumatic suspension unit for tracked vehicle in the 20 to 60 tonne class



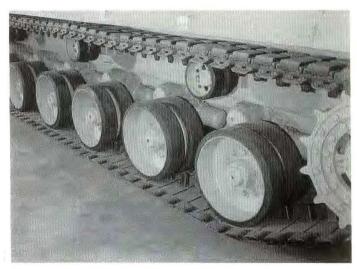
Dunlostrut suspension system installed on AMX-13 light tank upgraded to the AMX-13 SM1 standard by Singapore Technologies, Singapore Automotive Engineering Pte Ltd

Dunlostrut for wheeled vehicles

Experience gained by Dunlop with its Dunloride and Dunlostrut hydropneumatic suspension units for tracked vehicles led to the development of a Dunlostrut system for wheeled vehicles. The original design was in response to a request by ENGESA for a system for the new EE-18 (6 x 6) 105 mm tank destroyer. As of early 1993 the EE-18 had yet to enter production.

SPECIFICATIONS

Wheel load (static) 24.50 kN Wheel load (max at bump) 156.90 kN Wheel load (max side at bump) 58.84 kN



Close-up of the Dunloride hydro-pneumatic suspension system on the ENGESA EE-T1 Osorio MBT

Vertical wheel movement (static to bump) 200 mm Vertical wheel movement 100 mm (static to rebound) Static internal pressure 2.30 N/mm² Max working pressure 13.79 N/mm²

Unit weight 76 kg Operating ambient temperature range -25° to +60°C

Nitrogen - white spot grade

Manufacturer: Dunlop Aviation Division, Military Equipment, Holbrook Lane, Foleshill, Coventry CV6 4AA, UK

Telephone: (0203) 668729 Telex: 31677 Fax: (0203) 662294

Francis B Willmott Suspension Components

Development/Description

This company is a member of the Jonas Woodhead Group and specialises in the manufacture of vehicle suspensions and running gear, especially torsion bars, track pins and track connectors.

The company has installed a comprehensive manufacturing facility for torsion bars that incorporates special heat treatment and exclusive presetting equipment covering a wide range of sizes from 12 to 80 mm in diameter with lengths of up to 3000 mm.

Torsion bars can be manufactured for a wide range of vehicles including tanks, light tanks, armoured personnel carriers and self-propelled artillery systems.

The company is the only manufacturer of torsion bars for AFVs in the United Kingdom and a major part of the current work load is the supply of these for the Warrior and Multiple Launch Rocket System.

In June 1987 the company signed contracts to supply all of the torsion bar requirements for the European-built Multiple Launch Rocket Systems covering the period January 1988 to October 1993.

The first phase of this contract was the production facilitisation phase. This was followed by the production phase which is continuing. In addition, the company is supplying the counterbalance torsion bar for the cab of the MLRS which is being built by Vickers Defence Systems at Leeds

Track Pins

Pneumatic medium

A specialised plant manufactures a large range of track pins as original equipment and replacements. Steels of many different specifications are used, some of which are induction hardened and finally plated or phosphated to customer requirements. Standard designs can be produced in high and low volumes. In addition, a design facility is available and recommendations can be offered to users from drawings or samples.

Track pins can be supplied complete with rubber parts of appropriate design firmly bonded to the metal pin.

Track Connectors

A production unit has been established to manufacture a wide range of forged and cast steel and alloy connectors for multi-pin tracks fitted to MBTs and other armoured vehicles. The unit can also offer replacements for standard components currently in service, either from drawings or samples, as well as new designs for vehicles still under development.

The connectors can be supplied fully machined and hardened, either loose or as assemblies, complete with wedges, bolts and nuts.

Status: Production as required.

Manufacturer: Francis B Willmott, River Street, Birmingham B5 5SB, UK. Telephone: (021) 772 0907 Telex: 335141 FBWBHM G Fax: (021) 773 3621

Horstman Defence Systems Suspensions

Development/Description

Integrated Rotary Dampers

For the Warrior mechanised combat vehicle, now in service with the British Army (with the Desert Warrior version being selected by Kuwait in 1992). Horstman has combined the functions of an axle arm pivot and torsion bar mounting with a high performance damper to produce an integrated damper unit compatible with the widely accepted rotary torsion bar spring system.

The design gives over 90° of axle arm travel and a high level of controlled damping whilst operating temperatures remain well within acceptable limits.

The integrated rotary damper for the Warrior has a clean external profile which, according to Horstman Defence Systems, makes it highly resistant to damage caused by foreign objects or ballistic attack.

Late in 1985 Horstman was awarded a £7 million contract by GKN Defence for the supply of rotary dampers for the Warrior mechanised combat vehicle, with first production rotary dampers being delivered in 1986. Since then additional orders have been placed by GKN Defence.

In 1986 Horstman Defence Systems designed a rotary hydraulic suspension damper which is fitted to the first, second and sixth roadwheel stations of the private venture Vickers Mk 3(I) MBT to give an improved cross-country ride.

Lever Actuated Dampers

For vehicles unable to fully exploit their operational potential because of suspension limitations, Horstman has designed and manufactured a damper which can easily be retrofitted to the vehicle hull. This damper is actuated by a simple linkage from an existing damper mounting point.

The damper unit is mounted directly to the vehicle hull so that a good thermal conduction path is maintained, allowing for high levels of energy

The first application of the lever operated damper was the M113 technology demonstrator (see Engines, Transmissions and Powerpacks section).

For the M113 application the Horstman lever-actuated damper is a bolton unit for the first and last roadwheel stations either side. The M113 can be fitted with all four dampers in less than a day with the only work required being a template to position drill holes which are then tapped to bolt the unit in position.

The damper is actuated by a simple linkage from the existing shock absorber mounting point on the wheel arm.

Horstman has also designed and built a lever-actuated damper for the FV432 series of APC and the Scorpion CVR(T) to give a significant increase in cross-country speed.

In 1988 Horstman announced that a series of tests recently carried out by the Royal Armament Research and Development Establishment (Chertsey) had shown that significant improvements to the speed and agility of existing vehicles are possible simply by retrofitting the Horstman lever-actuated rotary damper.

The Royal Armament Research and Development Establishment fitted the rotary dampers to the SITV test vehicle which is based on an Alvis Scorpion chassis. They reported that over the most rigorous terrain profile, measured speeds were 2.5 times that achieved by the unmodified vehicle.

In addition to the M113, FV432 and Scorpion series, Horstman rotary dampers can also be fitted to other vehicles such as the French AMX-10 and AMX-13 and heavier vehicles such as the Leopard 1 and 2 and former Soviet T-series MBTs.

During 1989 Horstman applied its rotary damper technology to the T-series vehicles where the existing rotary shock absorber is replaced by a similarly sized Horstman rotary damper. This produced significantly higher levels of damping.

Late in 1992, Horstman Defence Systems announced that it had been selected to supply its lever actuated rotary damper system for the second prototype (PT02) of the Austrian/Spanish ASCOD armoured personnel carrier.

The running gear on either side of the ASCOD consists of six dual rubber-tyred road wheels with the drive sprocket at the front, idler at the rear and four track return rollers.

The road wheels have torsion bar suspension with the first two and last road wheel stations either side having a Horstman Defence Systems lever actuated rotary damper system.

Vehicle suspension lockouts

Horstman Defence Systems have also developed a loading system which immobilises the suspension of a vehicle at any position. Units can be either added to existing suspensions in a lever actuated arrangement or integrated into new systems.

The main advantages can be summarised as:

- (1) very high load capacity
- (2) effective overload limiting

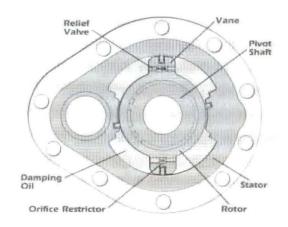


Horstman integrated rotary damper for GKN Defence Warrior

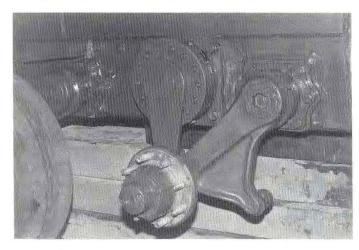
- (3) repeatable setting after overload
- (4) variable overload setting capability

Manufacturer: Horstman Defence Systems Limited, Locksbrook Road, Bath, Avon BA1 3EX, UK.

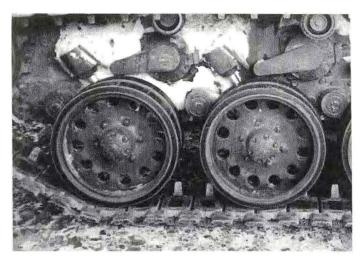
Telephone: (0225) 423111 Telex: 444363 Fax: (0225) 447357



Cutaway drawing of Horstman integrated rotary damper



Horstman integrated rotary damper for FMC M113 APC



Close up of Horstman lever actuated rotary damper fitted to ASCOD armoured personnel carrier

Vickers Defence Systems Hydraulic Track Tensioner

Development

The Vickers Defence Systems hydraulic track tensioner enables the rapid adjustment of track tension to be carried out without any of the crew leaving the vehicle.

The company produced its first hydraulic track tensioner in 1978 and this underwent some 6500 km of British Army trials. In 1986 a contrac* was awarded to Vickers Defence Systems covering the final design, development

and manufacture of hydraulic track tensioner systems for the Chieftain Armoured Vehicle Launched Bridge (AVLB) and Armoured Repair and Recovery Vehicle (ARRV) of the British Army. All production units are now in service on both vehicle types.

The AVLB carries a bridge which is launched over the front of the vehicle and this causes the track tension to change. The ARRV carries a powerpack weighing some 5 tonnes and, again, when this is unloaded, the track tension is affected.

A slightly different hydraulic track tensioner has been fitted to a British Army Challenger 1 for trials and a slightly modified version is fitted on all of the prototypes of the Challenger 2 MBT.

In January 1989 Vickers Defence Systems delivered two hydraulic track tensioners to General Dynamics, Land Systems Division. These were funded under the US Defense Department's Foreign Weapons Evaluation (FWE) programme.

They were installed on an M1 series MBT and completed a 9656 km durability trial at Yuma Proving Ground in Arizona.

Vickers Defence Systems can design hydraulic track tensioning systems to suit all full-tracked armoured fighting vehicles.

Description

The hydraulic track tensioner has two externally mounted double-acting rams linked to the front idler wheels, with the hydraulic power being provided by an electro-hydraulic pump mounted inside the driver's compartment. It is controlled by two directional control valves, one for each idler. Each ram cylinder has lock valves and a pressure relief valve

To tighten or slacken a track the driver selects the direction in which he wants the appropriate ram to move: to tighten the track he moves the ram forwards and to reduce the tension on the track the ram is moved backwards; the hydraulic pump is then operated. Once the required tension has been

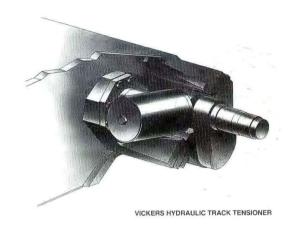
failure a hand pump is fitted. At present tank tracks have to be adjusted manually and this is a time consuming process and cannot always be accomplished under tactical conditions. If the track is incorrectly tensioned this can have adverse effects on fuel consumption, track life and track retention.

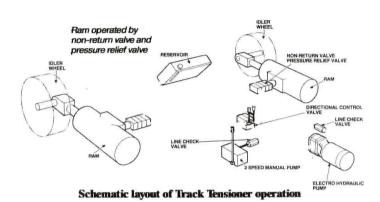
achieved the rams are automatically locked. In case of electro-hydraulic

Status: Development complete. Production as required. In service with British Army on Chieftain AVLBs and ARRVs.

Manufacturer: Vickers Defence Systems, Scotswood Road, Newcastleupon-Tyne NE99 1BX, UK.

Telephone: (091) 273 8888 Telex: 53104 Fax: (091) 273 2324





Vickers Defence Systems Dynamic Track **Tensioning System**

Development/Description

Under contract to United States Army Tank-Automotive Command, Vickers Defence Systems has designed, developed and delivered the Dynamic Track Tensioning System (DTTS) which will be installed on a M1 MBT and tested for performance and durability.

The overall goal of the programme is to develop a DTTS as a learning tool which will be accomplished by performing trade-off analysis between the control mechanism, power requirements, performance goals and idler configuration both on the test vehicle and through computer simulation

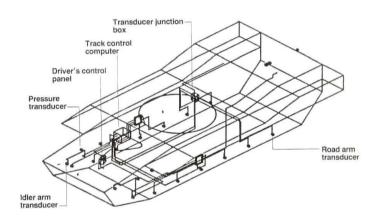
The DTTS measures the optimum track length when the vehicle is static by measuring the position of the idler and the angle of each road arm.

As the suspension moves up and down it computes the dynamic path length around the idler, underneath the wheels and up to the sprocket. This is compared with the optimum track length and the idler is positioned on a real-time basis to make the two equal, using the idler position to close a

The system is being designed with a high degree of redundancy with several backup operation modes and the ability for the track tension to be adjusted manually

The DTTS will be compatible with future suspension developments including active suspension systems.

According to Vickers Defence Systems, the main advantages of this system include: completely automatic track tensioning over any terrain; no intervention from the driver; increased combat effectiveness through fewer thrown tracks; increased performance; lower stresses on running gear



Dynamic Track Tensioning System installed in a MBT showing position of main components

components; reduced operation and support costs through longer track suspension component life; and reduced fuel consumption.

Manufacturer: Vickers Defence Systems, Scotswood Road, Newcastleupon-Tyne NE99 1BX, UK,

Telephone: (091) 273 8888 Telex: 53104 Fax: (091) 273 2324

UNITED STATES OF AMERICA

Combat Vehicle Suspension Technology

Development/Description

As part of its ongoing development work in various aspects of armoured vehicle technology for future armoured fighting vehicles, Tank-Automotive Command is looking towards new suspension systems.

These include the External Suspension System (ESS) in which all of the suspension components and functions are exterior to the hull of the vehicle. The ESS provides the ability to be tuned for optimum vehicle springing and damping for all gross vehicle weights within the heavy weight class (45 to 70 tons)

The suspension system also has the capability to have height control and lockout installed on an optional basis as vehicle mission requires

According to Tank-Automotive Command, the main features and benefits of the ESS can be summarised as follows

- (1) modular design and fewer parts
- (2) optimum spring and damping
- (3) weight class commonality
- (4) ability to install vehicle height control and suspension lockout
- (5) weight savings over torsion bar
- (6) reduced suspension system weight
- (7) elimination of internal hull space claim
- (8) lower vehicle silhouette
- (9) improved roadwheel and track life

(10) reduced suspension life cycle costs

(11) vehicle weight class commonality (optimised for 45 to 70 ton (US), gross vehicle weight vehicles.

Cadillac Gage Textron and Teledyne Continental Motors General Products have both developed ESS and details of these are given in the following two entries. These suspension systems are to be evaluated by the US Army on the Component Advanced Technology Test Bed (CATTB) chassis which is based on a M1A1 MBT chassis. The Cadillac Gage system will be tested first followed by the Teledyne Continental Motors system.

Tank-Automotive Command has awarded Vickers Defence Systems a contract for a new Dynamic Track Tensioning System. This system will be tested on an M1 outfitted with the Teledyne ESS. Details of this system are given earlier in this section.

Developing agency: United States Army Tank-Automotive Command, Warren, Michigan 48397-5000, USA.

Telephone: (313) 574 8687

Cadillac Gage Textron In-Arm Suspension Systems

Development/Description

Since the early 1980s Cadillac Gage Textron has been working on In-arm Suspension Units (ISUs) for AFVs as a private venture, although it has more recently received some research and development funding from the US Army Tank Automotive Command.

The first application of these in-arm suspension units is the General Dynamics, Land Systems Division, M1 series Abrams MBT for which the company claims the following advantages:

- (1) a saving of up to 1088 kg in weight compared to existing torsion bar systems
- (2) valuable hull space is made available with the removal of the torsion bars which can be used for additional fuel, ammunition or an APU, as the externally mounted ISUs do not intrude into the hull
- (3) the ISUs can be located optimally around the vehicle's centre of gravity and can be removed and installed very quickly. On the M1A1, the Cadillac Gage ISUs can use the existing torsion bar mounting bolt holes
- (4) the incorporation of an ISU system will provide a better ride due to nonlinear spring rate and optimised damping, so reducing crew member fatigue and improving performance
- (5) ISUs are designed to accommodate changes in vehicle weight and may incorporate advanced features such as ride, height and attitude control, lock-out and active or reactive damping
- (6) Cadillac Gage Textron ISU system is cost-competitive with torsion bar systems. It features life cycle cost-effectiveness and improvement in overall running gear durability. It is also expected that track life will be

An M1 Abrams MBT with a complete in-arm suspension system designed and built by Cadillac Gage Textron was completed in late 1985 and, following company trials in 1986, it went to the Waterways Experimental Station (WES), where its test results were compared to those of a standard M1 Abrams MBT fitted with its normal torsion bar suspension system. Cadillac Gage has also designed an in-arm suspension system for the M1A1 Abrams, M2/M3 Bradley, AAV7A1, M48, M60, Leopard 1, Leopard 2, together with T-54/T-55 and T-62 MBTs.

In 1988 Cadillac Gage Textron announced that they had expanded their range of bolt-on In-arm Suspension Units (ISUs) to three systems designated the 6K, 10K and 14K.

6K System

This has been designed for installation on lighter AFVs such as the M2/M3 Bradley. Cadillac Gage Textron has already been awarded a contract by the David Taylor Research Center for the supply of one complete vehicle set plus spares which were installed on a US Marine Corps AAV7A1 armoured amphibious assault vehicle in 1989. Following company trials it was handed over to the US Marine Corps for further trials.

Waterways Experimental Station. It can also be retrofitted to existing MBTs such as the M48, M60 Centurion and former Soviet T-series vehicles. 14K System one of which is being used for in-house trials.

10K System

This system has been designed for installation on heavier MBTs such as the M1A1 Abrams and the company has built two complete vehicle sets,

This was the first system to be developed by Cadillac Gage Textron under

an independent research and development programme and the company was subsequently awarded a TACOM contract for one vehicle set, which

was then installed on an early M1 several years ago for trials at the

Both Cadillac Gage Textron and Teledyne Continental Motors, General Products Division, have also each been awarded contracts for one complete set of suspension systems which are for the US Army's Component Advanced Technology Test Bed (CATTB) chassis which is based on a M1A1 MBT.

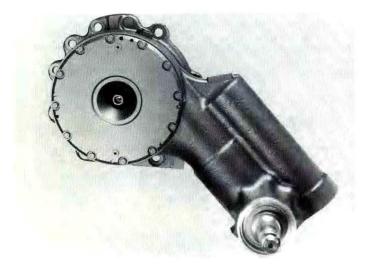
All Cadillac Cage Textron ISUs comprise a separate spring and damper assembly contained within a single housing structure. A wet friction disc mechanism is controlled and activated by a low power hydraulic control system. The spring is a hydro-pneumatic type comprising a piston and connecting bar positioned within a cylinder bore acting on a nitrogen gas over a hydraulic spring medium. The specific damping characteristics of the units are tailored to meet customer and/or specific vehicle requirements.

In the case of the M1 units, they are a direct replacement for the existing units with the added advantage of a significant weight and space saving due to the removal of the existing torsion bars.

SPECIFICATIONS			
Model	14K	10K	6K
OPERATING LOAD		15001	
(static position)	6350 kg	4536 kg	2722 kg
OPERATING LOAD			
(bounce stop position)	19 051 kg	13 608 kg	9798 kg
MOUNTING	all are bolt	on external to ve	hicle hull
WEIGHT (damped)	227 kg	238 kg	117 kg
WEIGHT (undamped)	128 kg	215 kg	107 kg
JOUNCE TRAVEL	381 mm	381 mm	317 mm
REBOUND TRAVEL	152 mm	127 mm	133 mm
TOTAL TRAVEL	533 mm	508 mm	450 mm
ROAD ARM LENGTH	431 mm	394 mm	406 mm
SERVICE CHECK	all are che	cked at 6 month in	ntervals

Other systems

More recently Cadillac Gage Textron has moved into other areas of suspension technology including track tensioning systems, rotary dampers and torsion bars, the last of these including rotary damping, active damping and super plus bars.



Cadillac Gage Textron 6K in-arm suspension unit, one set of which has been installed on a US Marine Corps AAV7A1 for trials

Status: Prototype systems undergoing trials.



Cadillac Gage Textron 10K in-arm suspension unit which can be retrofitted to MBTs such as the M48, M60, Centurion and T-series

Manufacturer: Cadillac Gage Textron, Advanced Mobility Systems, PO Box 1027, Warren, Michigan 48090, USA

Telephone: (313) 777 7100 Telex: 2000707 Fax: (313) 776 9731



Cadillac Gage Textron 6K in-arm suspension system mounted on a US Marine Corps AAV7A1 vehicle for trials purposes

Teledyne External Suspension Systems

Development/Description

The Teledyne External Suspension System (ESS) Model 3870 is a high performance hydro-pneumatic suspension available for new vehicle production or retrofit programs. The Model 3870 is the result of extensive experience in the design, development and production of ESS by the General Products Division of Teledyne Continental Motors.

The major technical benefits of the ESS include increased wheel travel and a multi-rate spring. This translates into higher vehicle speeds across uneven terrain and a more comfortable ride for crew and equipment. Since the stability of the moving vehicle is upgraded, weapon system accuracy is improved during fire-on-the-move operations.

Practical benefits of the ESS include the external bolt-on attachment which allows for an increase of usable interior hull space. The highly adjustable ESS can accommodate vehicle weight changes from 45 to 70 tons. The Model 3870 is designed for long life and low maintenance for reduced operations and support costs.

Teledyne has demonstrated the height control and lockout options with their ESS and these features allow an MBT to reduce vehicle profile, increase gun elevation or depression or, with a blade attachment, act as an effective dozer

TCM External Suspension System experience:

Year	Application
1980	Jordanian Centurion production contract
1983	Swiss Centurion trials
1983	Indian MBT trials
1984	TCM AGS prototype
1984	Turkish M48 trials
1984	zero leakage seal study
1985	Saudi Arabian M60 trials
1985	Swiss Pz 68 trials
1986	Egyptian T-54 trials (Ramses II)
1986	TACOM development contract phase I
1987	Italian VCC-80 trials
1988	TACOM development contract phase II
1989	M1A1 trials contract
1989	TCM ESS proposed by all HFM competitors
1990	70 ton M1 trials.

External Suspension System features claimed by TCM:

Performance

Non-linear multi-rate spring, more aggressive track tensioning, higher crosscountry speed, high roadwheel travel, increased fire-on-the-move accuracy.

Design

Mature and proven, light weight, hydraulic, non-wearing damping and bolton fit

Adjustable

45 to 70 tons, spring rate and optimised damping.

Common modules at each station, interchangeable damping manifold, low maintenance requirements, 9656 km life and no interior space claim.

Height control and lock-out.

Vehicle modernisation

TCM has developed modernisation programmes for the US Army's M series and foreign main battle tanks, including the former Soviet T-series, AMX-30 and Centurion vehicles. These modernisation programmes utilising new technology and the advanced hardware, can provide for the upgrading of any or all of the vehicle subsystems, exactly fitted to customer requirements. TCM has integrated MBT modernisation programmes with the following systems: high performance powerpacks; dieselisation kits; main gun and armour enhancements; fire control systems; external suspension systems; fire suppression; night vision devices; turret drive and stabilisation.

Depending upon customer requirements, TCM can provide any level of technical support including total turn-key modernisation programmes encompassing completely upgraded vehicles utilising local labour.

TCM Model 3870 ESS

The TCM Model 3870 is specifically designed for the M1 MBT, but is adaptable to any moderate to heavy tracked vehicle. The 3870 is an in-arm design in which a single actuator cylinder rotates on a fixed crank and moves an actuator piston. This forces the hydraulic working fluid through valving into two pressurised, sealed accumulator cylinders of hydraulic oil and nitrogen gas. By controlling the oil flow through valving into cylinders against free floating pistons separating the gas and oil, the unit absorbs energy and provides the required spring and damping functions.

The two critical parameters of spring and damping may be adjusted by changing valves, pressure and/or oil levels in each unit. The unit can be easily tuned for special terrain, weather and vehicle conditions through protected charging valves located on the top of the unit. The units operate on standard military hydraulic oil and nitrogen gas.

The operation principles are based on rotation and hydraulic flow for efficient, non-wearing, frictionless damping. The effectiveness of this unit has been successfully field-tested in conditions of over +140°F (60°C) ambient.

The 3870 is modular in that each station is a common unit with the exception of the interchangeable damped or undamped bolt-on manifolds. This unit also allows for the attachment of track tensioning arms for improved track tensioning in direct relation to road wheel travel.

Teledyne offers the in-arm model for both tub-shaped and vertical-sided vehicles. This provides full coverage to existing and emerging vehicles for the most flexible and cost-effective high performance suspension available.

SPECIFICATIONS

SPECIFICATIONS		
Model	3870	
CAPACITY	4536 kg	
WEIGHT	204 kg includes spindles and	
	mounting pads	
ROADWHEEL TRAVEL	508 mm	
ROADWHEEL JOUNCE	381 mm	
ROADWHEEL REBOUND	127 mm	
LENGTH	431 mm	
WORKING FLUID	hydraulic fluid - MII -H-46170	

Future suspensions

In addition to developing their External Suspension System (ESS), Teledyne Continental is also studying even more advanced suspension systems. including active track tensioning (with Vickers Defence Systems and Lotus also involved), adaptive suspension damping (with Lotus), active suspension (with Lotus) and more into the future active suspension using standard suspension plus hydraulic assist.

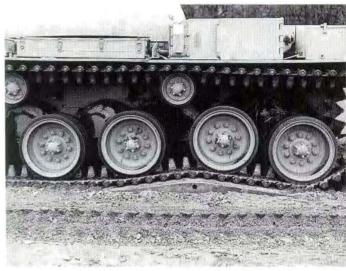


Model 3870 External Suspension System for M1 MBT

Status: Development complete.

Manufacturer: Teledyne Continental Motors General Products, 76 Getty

Street, Muskegon, Michigan 49442, USA. Telephone: (616) 724 2151 Telex: 228 426



Ramses II MBT fitted with Teledyne Continental hydro-pneumatic suspension

AFV Turrets and Cupolas

(only turrets and cupolas which are currently available or under development are included in this section)

ARGENTINA

DGFM 105 mm TAM Tank Turret

Development

The TAM tank turret is fabricated at the Fábrica Militar 'Ro Tercero armaments factory using materials and components supplied by a number of subcontractors including the Altos Hornos Zapla steelworks, the Somisa steelworks and the Fábrica Militar San Martin Armaments factory. Its use is currently confined to the TAM medium tank designed by Thyssen Henschel for the Argentinian Army and subsequently built in that country by the manufacturer TAMSE. The turret can be adapted for use on other armoured vehicles.

Description

The turret is of all welded steel construction with the commander and gunner on the right and the loader on the left. The commander is provided with a single piece hatch cover and eight periscopes. Mounted in front of his hatch is a non-stabilised Steinheil Lear Siegler TRP-2A panoramic sight with a magnification of between × 6 and × 20. This can be replaced by an infra-red sight unit. The commander also operates the coincidence



The gunner is seated forward and below the commander and is provided with a × 8 magnification Zeiss TZF sight combined with a swivelling and tilting periscope.

The loader is provided with a single piece hatch cover that opens to the rear and with a tilting periscope mounted in front of his position

Main armament is a locally developed 105 mm gun (covered in AFV Armaments section) although the Rheinmetall Rh 105-30 can also be fitted. Both weapons fire all standard 105 mm tank ammunition. An ammunition loading port is provided in the left side of the turret with space for 20 rounds to be stored in its confines.

The gun is provided with a bore evacuator, thermal sleeve and is fully stabilised in both planes. Mounted coaxially is a 7.62 mm MAG machine gun manufactured under licence. A similar weapon is mounted on the roof of the turret for anti-aircraft defence. Four smoke dischargers are mounted on either side of the turret's rear section.

SPECIFICATIONS

CREW 3 (commander, gunner, loader) ARMAMENT 1×105 mm aun coaxial 1×7.62 mm MAG MG anti-aircraft 1 × 7.62 mm MAG MG smoke dischargers **AMMUNITION**

20 rounds (in turret) main secondary 6000 rounds **OPTICS**

one TRP-2A panoramic sight (× 6 to × 20 commander magnification)

one coincidence rangefinder

eight periscopes

one Zeiss TZF sight (x 8 magnification)

aunner combined with swivelling and tilting periscope

loader one tilting periscope

WEIGHT 2050 kg DIMENSIONS 3.425 m lenath

width height 0.67 m

Status: Production as required. In service with the Argentinian Army (TAM medium tank).

Manufacturer: Direccion General de Fabricaciones Militares (DGFM). Cabildo 65, Buenos Aires, Argentina,

TAM medium tank fitted with DGFM 105 mm welded steel turret

DGFM 20 mm VCTP Turret

Development/Description

The 20 mm VCTP turret is fabricated at the Fábrica Militar 'Ro Tercero armaments factory using materials and components supplied by a number of subcontractors including the Altos Hornos Zapla steelworks, the Somisa steelworks and the Fábrica Militar San Martin Armaments factory. Its use is currently confined to the VTCP infantry combat vehicle designed by Thyssen Henschel for the Argentinian Army and subsequently built in that country by the manufacturer TAMSE. The turret can be adapted for use on other armoured vehicles

The two-man turret is armed with a 20 mm cannon and a roof-mounted 7.62 mm MAG machine gun. A full range of optical sights and periscopes is provided for the crew.

SPECIFICATIONS

CREW 2 (commander, gunner) ARMAMENT main 1 x 20 mm automatic cannon secondary 1 × 7.62 mm MAG MG WEIGHT 1050 kg DIMENSIONS 1.56 m length width 1.46 m height 0.62 m



The VCTP infantry combat vehicle is fitted with a two-man DGFM 20 mm

Status: Production as required. In service with the Argentinian Army (VTCP infantry combat vehicle).

Manufacturer: Direccion General de Fabricaciones Militares (DGFM), Cabildo 65, Buenos Aires, Argentina.

AUSTRIA

Steyr SP3/300 Weapon Station

Development

The SP3/300 two-man weapon station was designed by Steyr-Daimler-Puch for use on MICV and reconnaissance type vehicles such as the ASCOD (developed by Steyr and SANTA BARBARA) and Steyr Pandur ARSV 30.

Description

The turret is of all-welded construction and provides protection against up to 30 mm APDS rounds from 1000 m in the frontal area and against small arms and shell fragments all round.

The main armament consists of a gas operated MK 30 mm x 173 automatic cannon, with a coaxial 7.62 mm machine gun mounted to its left as the secondary weapon. The automatic cannon is a gas-operated weapon with a maximum firing rate of approximately 800 rds/min. The belted cartridge ammunition is fed via a dual belt feeder so that a change of ammunition type results in no loss of firing capability.

Cocking of the bolt, actuation of the dual belt feeder and firing is performed by means of electromechanical actuators. The weapon can be operated by both the gunner and the commander.

The vehicle commander sits on the left side of the weapon station with the gunner on the right. Both have adjustable seats and rear opening single-piece hatch covers in the roof.

The gunner's fire control system is a modular thermal and visible target acquisition system with ground/ground and limited ground/anti-aircraft capabilities. The system consists of:

(a) optical sight with thermal channel and gunner's display (TV monitor)

(b) integrated laser rangefinder



Stevr-Daimler-Puch Pandur ARSV 30 vehicle fitted with the Stevr SP3/300 weapon station

- (c) digital Fire-Control Computer (FCC) with cant sensor providing improved firing performance by automatic determination of super elevation and azimuth lead as a function of ammunition type, range, turret azimuth rate and cant angle. Five types of 30 mm ammunition (HE, APDS, MPDS, APFSDS and MP) and 7.62 mm Ball/AP can be processed
- (d) gunner's station Computer Control Panel (CCP)
- commander's station remote display (TV monitor giving identical image to gunner's thermal display)
- a turret position indicator gives the driver, commander and gunner the turret position related to the hull.

In addition, a periscopic daylight sight is provided for the commander. The commander has a further five and the gunner has two panoramic episcopes around their hatch covers for general observation of the surrounding terrain.

Turret traverse and weapon elevation are carried out by the commander using electric power controls. The gunner has a manual backup system.

CDEC	CAT	Γ	NIC
SPEC	LA	ш	NO

CREW ARMAMENT 1 × 30 mm MK 30 cannon 1 × 7.62 mm MG (various types) **AMMUNITION** 215 rounds 30 mm (135+80) ready-use, 550 rounds 7.62 mm ready-use

smoke dischargers 2 banks (66, 76 or 81 mm calibre options)

CONTROLS operation

electromechanical operated with 2-axis gyro stabilisation and backup manual

traverse min/max velocity 0.3/0.9 mrad/s depression/elevation -10 to +50° min/max velocity 0.3/0.8 mrad/s

OPTICS

laser integrated periscopic sight: × 8 aunner magnification, 8° FOV

laser rangefinder: unity prism, × 1 magnification, 36° × 25° FOV thermal imaging channel: narrow \times 8.4

magnification, 1.1° × 2.2° FOV; wide \times 2.8 magnification, 3.4° \times 6.8° FOV

commander periscope sight: × 6 magnification, 170 mil FOV and × 2 magnification,

570 mil FOV

WEIGHT (without crew) 2500-3400 kg (depending upon required

protection level) POWER SUPPLY

Status: Trials. Ready for production.

Manufacturer: Steyr-Daimler-Puch Spezialfahrzeug AG, PO Box 100,

A-1100 Vienna, Austria,

Telephone: 0222 764511 Telex: 61322 1299 stdpsi a

Steyr SP2/300 Weapon Station

Development/Description

The SP2/300 is similar in design philosophy and armour protection to the SP1/127 one-man weapon station. It has undergone successful trials with the Austrian Army and is now ready for production.

The main armament consists of a recoil-operated self-loading British Royal Ordnance 30 mm L21A1 RARDEN automatic cannon with a coaxially mounted 7.62 mm MAG machine gun. Six smoke dischargers are fitted in banks of three on either side of the turret rear.

The 30 mm cannon can either fire single shots or bursts of up to six rounds with a cyclic rate of fire of approximately 90 rds/min. A total of 84 rounds is carried in clips of three, of which 20 are stowed in a rotatable ammunition magazine beneath the turret bearing. The remaining eight clips are in two containers on the turret platform.

The turret operator is provided with an adjustable seat, a rear opening single-piece hatch cover in the roof and one Philips UA 9126 roof-mounted periscopic sight with a changeable × 6/× 2 magnification daylight channel and a ×7 magnification passive image intensifier night sight channel for target acquisition and aiming. The sight also has adjustable illumination of the stadia graticule for ground firing and an elliptical graticule for use against aerial targets.

Attached to the sight is a unitary prism which, together with four panoramic episcopes around the hatch, provide for observation of the surrounding terrain. Turret traverse and weapon elevation are hydraulic power controlled with manual backup.

The coaxial machine gun is mounted to the left of the 30 mm RARDEN cannon in an external turret position. Belted 7.62 mm ammunition is fed mechanically to it from a metal plate storage box through flexible channels. The machine gun is cocked electrohydraulically by hydraulic cylinders and fired by electrical impulses. A warning light in the weapon station informs the operator when he is about to exhaust the supply of ready-use ammunition.

SPECIFICATIONS

CREW one ARMAMENT 1 × 30 mm L21A1 RARDEN cannon

1 × 7.62 mm MAG 58 MG 84 30 mm HE-T, APDS-T or TP-T rounds AMMUNITION 600 rounds 7.62 mm ready-use

smoke dischargers 2×3

CONTROL

OPTICS

operation electrohydraulically powered with backup manual

360° at 45°/s elevation/depression -10° to +40° at 30°/s

UA 9126 periscopic sight with × 6/× 2 interchangeable day channel, a × 7 image intensifier night sight and a × 1 prism block

four × 0.76 wide angle episcopes

1250 kg WEIGHT (without operator) POWER SUPPLY 24 V DC Status: Ready for production.

Manufacturer: Steyr-Daimler-Puch Spezialfahrzeug AG, PO Box 100,

A-1100 Vienna, Austria

Telephone: 0222 764511 Telex: 61322 1299 stdpsi a



Steyr-Daimler-Puch 4K 7FA-MICV 30/1 fitted with Steyr SP2/300 one-man weapon station (Christopher F Foss)

Steyr SP1/127 Weapon Station

Development

The Steyr SP1/127 one-man weapon station was designed as a private venture by Steyr-Daimler-Puch for installation on a wide range of tracked and wheeled armoured vehicles such as the Steyr Pandur APC/MICV and the Steyr 4K 7FA-MICV 127. It is also available as an upgrade package for M113 family vehicles using the interface of the cupola's bearing.

Description

The turret is of all-welded construction and provides the operator with protection from 20 mm calibre SAPHEI projectiles in the frontal area and against small arms and shell fragments all round.

Installed on the turret as the main armament is a 12.7 mm M2 HB heavy machine gun, with a coaxial 7.62 mm MAG machine gun as the secondary weapon. These are located externally in a cradle in front of the turret bustle and can be used to engage both ground and air targets. There is also a smoke discharging system, with two banks of dischargers mounted on the turret rear.

The turret operator has an adjustable seat, a rear opening single-piece hatch cover in the roof and one roof-mounted periscope sight with $\times\,6$ magnification/6° field-of-view and $\times\,1$ magnification/30° $\times\,15^\circ$ field-of-view for target acquisition and aiming. The sight also has adjustable illumination of the stadia graticule for ground firing of the two machine guns and an



elliptical graticule for using the 12.7 mm machine gun against aerial targets. A day/night sight is an option.

Attached to the sight is a unitary prism which, together with four further panoramic episcopes around the hatch, provide for observation of the surrounding terrain. Turret controls are manual, with hydraulic weapon traverse and elevation systems.

Belted 12.7 mm and 7.62 mm ammunition is fed mechanically through flexible channels to the individual machine gun, which is cocked electrohydraulically by hydraulic cylinders and fired by electrical impulse. The operator can select either the 7.62 mm machine gun or the 12.7 mm heavy machine gun to fire. A warning light in the weapon station informs him when he is about to run out of ready-use ammunition. The empty cartridge cases and belt links are ejected automatically outside the weapon station.

SPECIFICATIONS

SPECIFICATIONS	
CREW	one
ARMAMENT	1 × 12.7 mm M2 HB MG
	1 × 7.62 mm MAG 58 MG
AMMUNITION	600 rounds 12.7 mm
	ready-use
	800 rounds 7.62 mm
	ready-use
smoke dischargers	2 banks (66, 76 or 81 mm calibre

CONTROLS

traverse 360°
elevation/depression -15° to +50°
OPTICS single periso

PTICS single periscope day sight with × 6 aiming

with × 6 aiming and × 1 prism block four × 0.76 wide angle episcopes 1100 kg 24 V DC

options)

Status: Ready for production.

WEIGHT (without operator)

POWER SUPPLY

Manufacturer: Steyr-Daimler-Puch Spezialfahrzeug AG, PO Box 100,

A-1100 Vienna, Austria.

Telephone: 0222 764511 Telex: 61322 1299 stdpsi a

Steyr-Daimler-Puch SP/127 weapon station installed on a Steyr Pandur MICV 127

BELGIUM

Cockerill CSE 90 mm Turret

Development

The CSE 90 mm turret has been designed as a private venture by CMI for the export market. The turret armed with the Cockerill 90 mm Mk III gun has been installed on all the 162 SIBMAS Armoured Fire Support Vehicles ordered by the Malaysian Army late in 1981, which have now been delivered. For trials the CSE 90 mm turret has also been installed on the Vickers Defence Systems Valkyr (4 \times 4), GKN Defence Warrior, Steyr-Daimler-Puch Kürassier and an M113A2 APC. Early in 1985 it was announced that Cockerill had purchased an M113A1-B APC from Belgian Mechanical Fabrication (BMF), which was subsequently fitted with the CSE 90 mm turret and demonstrated as a fire support vehicle. In this version the vehicle can still carry 10 fully equipped infantry plus its crew of three, the commander, gunner and driver. To enable the vehicle to remain amphibious, flotation panels have been attached to the hull sides.

Description

The turret is of all-welded steel construction with the commander/loader sitting on the left and the gunner on the right. The turret provides complete protection against 5.56 mm and 7.62 mm small arms fire from all directions.

Main armament is a Cockerill 90 mm Mk III gun with a recoil of 300 mm. A 7.62 mm machine gun is mounted coaxially to the left of the main armament and a similar weapon can be mounted on the turret roof for anti-aircraft defence. Eight electrically operated smoke dischargers are mounted either side of the turret.

The commander has seven observation periscopes and the gunner four. Both have a roof-mounted sight with magnifications of \times 8 and \times 1 with a projected graticule for aiming the gun and a wiper blade. Turret traverse and weapon elevation/depression are either electrohydraulic or electric, with manual backup for emergency use. A device is fitted which automatically makes the gun clear the vehicle deck, with manual override.

Standard equipment includes slip ring, turret blower for removing fumes and a basket. Optional equipment includes a 500 000 candlepower

searchlight mounted coaxially to the left of the 90 mm gun, 66 mm or 76 mm multi-purpose grenade launchers, commander's cupola with vision periscopes for improved all-round observation, indirect firing control system with computerised angular indicator, and various types of sights for the commander and gunner including day, image intensifier, thermal sight, laser rangefinder and ballistic computer. Various thermal sights were evaluated on the turret during 1990-91.

Optional Armour

The CSE 90 mm turret can be fitted with additional armour protection against penetration by armour-piercing projectiles, as requested by the customer.

These bolt-on plates are made of armoured steel and composite materials and can be quickly replaced by a new plate if damaged or hit.



CSE 90 mm turret with 7.62 mm anti-aircraft machine gun, searchlight and smoke/fragmentation grenade launchers installed on a SIBMAS (6×6) APC as delivered to Malaysia

SPECIFICATIONS CREW 2 (commander and gunner) ARMAMENT

 (ready-use in turret)

 90 mm
 12

 7.62 mm coaxial
 400

 7.62 mm AA
 200

 smoke grenades
 8 + 8

 CONTROL

traverse 360° at 30°/s
electromechanical
elevation -10° to +30° at 30°/s
electromechanical

OPTICS commander 7 periscopes, sight

with magnification of × 1 and × 8
gunner 4 periscopes, sight with magnification of

× 1 and × 8

WEIGHT

(with ammunition) 2100 kg

Status: Production as required. Known to be in service with Malaysia on SIBMAS 6 \times 6 vehicles.

Manufacturer: CMI, Cockerill Mechanical Industries SA, Avenue Greiner

1, B-4100 Seraing, Belgium. Telephone: 32 41 30 21 11 Telex: 41225 CKL SAM B

Fax: 32 41 30 25 26

Cockerill C25 25 mm Turret and Cockerill CB30 30 mm Turret

Development

The C25 is a joint development between Cockerill, responsible for the turret and systems integration, and Oerlikon-Contraves, responsible for the 25 mm KBB cannon. For trials purposes the turret has already been installed on the SIBMAS (6 \times 6), M113A1-B, Puma, Valkyr and Warrior armoured vehicles.

The C25 turret is under evaluation by the Norwegian and Swiss armies. The fully stabilised turret is equipped with the Officine Galileo fire-control system and a thermal sight. The turret is installed on the Krauss-Maffei Puma chassis for the trials.

For the same projects and based on the design of the C25 turret configuration, Cockerill is designing a 30 mm turret with the same overall design features. The main armament is the Mauser 30 mm Model F cannon; as an alternative it can be fitted with the 30 mm MDH Bushmaster II Chain gun. The turret is scheduled to undergo customer evaluation in 1993 and has been named the CB30.

The turret weapon system has been designed to achieve high hit probabilities whilst firing on the move against moving ground targets, as well as in the anti-aircraft mode of fire.

Description

The turret is of all-welded steel armour construction and can be delivered with ballistic protection against penetration by armour-piercing projectiles, as required by the customer. The additional armour protection is provided by add-on composite panels fastened to the turret. These are lightweight and can be replaced in the field if damaged by impact.

The commander is seated on the left side with the gunner on the right; each is provided with a single-piece hatch cover that opens to the rear. The gunner has three observation periscopes to his right, while the commander has seven periscopes. In addition, both turret members have a day or day/night sight for aiming the weapons which also incorporates an observation channel.

Main armament comprises an Oerlikon-Contraves 25 mm KBB cannon with a 7.62 mm machine gun mounted coaxially to the left. Mounted either side of the turret towards the rear is a bank of four electrically operated smoke dischargers. The empty 25 mm cartridge cases are ejected from the turret on the forward right side.

Turret drive is electromechanical and controlled by commander or gunner with the former having override. Turret traverse is 360° and weapon elevation is from –10° to +60°. The high angle of elevation enables it to be used to engage low flying aircraft and helicopters.



Cockerill C25 turret, Officine Galileo Janus anti-aircraft sight, thermal sight, Oerlikon-Contraves 25 mm KBB cannon and 7.62 mm coaxial MG

In a joint development programme with Officine Galileo of Italy, CMI has installed a Janus anti-aircraft sighting system on the C25 turret. Firing trials of this modified turret on a Belgian Air Force practice range against towed airborne targets gave outstanding first round hit probabilities.

The turret is fully stabilised by means of turret and vehicle-mounted gyros. The various turret functions at the turret crew's disposal are controlled from a box containing solid state components only, mounted on plug-in printed circuit boards. This arrangement gives a high degree of reliability, rapid fault-finding by the use of a separate test unit and instantaneous repairs through circuit board substitution.

Toxic gases produced by the 25 mm cannon and 7.62 mm coaxial machine gun are removed by two ventilated exhaust fans. A 500 000 candlepower white light searchlight is mounted coaxially with the main armament.

As an alternative this turret may be fitted with an Oerlikon-Contraves 25 mm KBA cannon, 25 mm Mauser Model E cannon or a McDonnell Douglas Helicopter M242 25 mm Chain Gun. A single TOW launcher can be fitted to the right side of the turret and associated with an electronic control system and thermal imaging day/night sight with built-in tracker. Various sighting and fire control systems are available for the Cockerill C25 turret depending on the user requirements.

SPECIFICATIONS

CREW COMBAT WEIGHT

3000 kg

ARMAMENT main

1 × 25 mm KBB cannon 1 × 7.62 mm MG

coaxial smoke dischargers

2 × 4

AMMUNITION

smoke grenades

TURRET DRIVE

AIRTIGHTNESS

ELEVATION/TRAVERSE

TRAVERSE

FLEVATION

RATES

GYROS

VISION

coaxial

main

100 APDS-T + 150 HEI (2 boxes) ready rounds 250 ready

(+ 500 stowed in

turret) 8 ready

(+ 8 stowed in turret)

electromechanical 360

-10° to +60°

0.5 mils/s to 45°/s max 2 axes

2 sights. 10 periscopes NBC system

compatible

Status: Ready for production.

Manufacturer: CMI, Cockerill Mechanical Industries SA, Avenue Greiner

1, B-4100 Seraing, Belgium.

Telephone: 32 41 30 21 11 Telex: 41225 CKL SAM B

Fax: 32 41 30 25 26

BRAZIL

Moto Pecas Gunner's Shield for M113 Commander's Cupola

Development

As part of the upgrade programme for the Brazilian Army M113 APCs, Moto Pecas developed a Gunner's Shield system for bolt fitting to the commander's cupola. Production for the Brazilian Army has finished but the system is being offered for export.

Description

The shield comprises one frontal flat piece and two conically shaped lateral pieces made from 6.35 mm SAR T armoured steel plate. This provides protection against standard NATO 5.56 mm and 7.62 mm small arms ammunition.

Combat weight is 145 kg with the shield being capable of a full 360° traverse. Main armament is a 12.7 mm (0.5 in) M2 HB heavy machine gun.

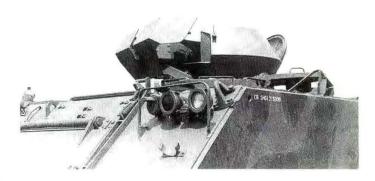
Status: Production as required. In service with the Brazilian Army (on upgraded M113 APCs).

Manufacturer: Moto Pecas, Avenue Hollingsworth, 719, CEP 18.100

Sorocaba SP, Brazil.

Telephone: 55-152-329444 Telex: 152-145 MPTE BR

Fax: 55-152-323675



Moto Pecas Gunner's Shield for M113 Commander's Cupola but without 12.7 mm machine gun installed

CANADA

Linamar Group TOW-Armoured Launching Turret (ALT)

Development/Description

In 1988 Invar Manufacturing and Linamar Machine Ltd of the Linamar Group began the production under licence from Kvaerner-Eureka of Norway of 72 ALTs as part of the Phase I TOW Under Armour Project contract from the Canadian Department of National Defense (together with six turret trainers). A further 30 ALTs to be ordered for delivery as part of the Phase Il acquisition programme was cancelled in May 1991.

The turrets are equipped to fire Basic TOW, Improved-TOW or TOW-2 ATGWs and are mounted on M113 APC rear decks.

A Crew Commander's Target Acquisition System (CCTAS) is available as an option.



SPECIFICATIONS CREW LENGTH 1.755 m launcher horizontal WIDTH 1.060 m HEIGHT 1.103 m hatch closed hatch opened 1.219 m WEIGHT 930 kg TRAVERSE 360" TRAVERSE SLEW RATE 0-9°/s TRAVERSE TRACKING RATE 0-20/5

 $\begin{array}{ll} \hbox{ELEVATION} & -15^{\circ} \ \hbox{to } +15^{\circ} \\ \hbox{ELEVATION TRACKING RATE} & 0-3^{\circ} / \mathrm{s} \end{array}$

Status: Production of 72 (under licence) ended in 1992. Further production as required.

In Service with the Canadian Armed Forces (on M113).

Manufacturers: Linamar Machine Ltd, 301 Massey Road, Guelph, Ontario, N1K 1B2, Canada.

Telephone: (519) 836 7550 Fax: (519) 824 8479

Invar Manufacturing Ltd, 1 Parry Drive, Batawa, Ontario, K0K 1EO, Canada. Telephone: (613) 398 6106 Telex: 06 62255 Fax: (613) 966 7932

COMMONWEALTH OF INDEPENDENT STATES

7.62 mm TKB-0149 One-Man Machine Gun Turret

Development/Description

The TKB-0149 one-man turret is designed for use with light armour and security vehicles used in the protection of mobile and fixed assets.

The 7.62 mm machine gun is hand laid and can engage targets at ranges of up to 1500 m. A full range of day and night surveillance systems can be fitted, as can a loud speaker system for crowd control.

SPECIFICATIONS

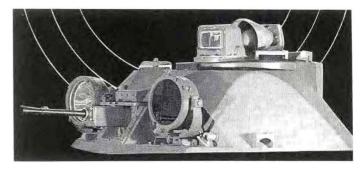
CREW 1 (gunner) ARMAMENT $1 \times 7.62 \text{ mm MG}$

AMMUNITION (ready-use) 2 × 250 round box magazines
CONTROL manual traverse and elevation
ELEVATION/DEPRESSION +10°/-8°

OPTICS day and night surveillance

WEIGHT 340 kg
POWER SUPPLY 27 V DC

Status: Production as required. In service with the CIS.



The one-man turret type 7.62 mm TKB-0149 is designed for installation on light armoured vehicles

Manufacturer: Enquiries to: 2, Mosin St, 300002, Tula, Russia.

Telephone: (0872) 31 74 65 Telex: 253114 ALFA SU

Fax: (0872) 27 26 20

FRANCE

Giat Industries 105 TGG Turret

Development

The 105 TGG turret was developed originally for use on the AMX-10RC (6 \times 6) wheeled reconnaissance vehicle. It has also been trialled on the Krauss-Maffei Puma ACV and can, if required, be adapted for other tracked or wheeled AFV types.

Description

The all-welded aluminium turret provides the crew with protection from small arms fire and shell splinters. Optional add-on ballistic armour is available. There is also a collective NBC system fitted.

The commander and gunner are seated on the right with the loader seated on the left. Both the commander and loader are provided with single-piece hatch covers that open to the rear.

The commander has six periscopes for all-round vision and a periscope and panoramic M389 telescope with magnifications of $\times 2$ and $\times 8$ which has full contra-rotation and enables him to observe a target regardless of the position of the turret. The commander also has overriding controls allowing him to lay the gun onto the target.

The gunner has two periscopes and an M504 telescope which is the main part of the COTAC fire control system. The M504 has a magnification of × 10 and is combined with an optical compensator (with control electronics for automatic input of fire corrections), M550 laser rangefinder unit and an M553 boresight assembly which corrects any abnormal drop or accidental misalignment of the main armament.

The loader has three periscopes: one to his front, one to his left and one to his rear.

Night vision equipment for observation and identification such as a low-light-level camera with a range of up to 4000 m or an infra-red sight with a range of up to 1000 m can be fitted as an option.

The main armament uses electrohydraulic gun laying with manual backup controls and can either be a semi-automatic 105 mm Giat Industries 105 F2, a 105 mm Giat Industries 105 G2 (NATO standard) or Rheinmetall 105 mm Rh105-20 SLR gun. With APFSDS projectiles, the former can defeat 360 mm of armour at 2500 m range. A total of 10 ready-use rounds are stowed in the turret.

Mounted to the left of the gun is an electrically fired coaxial 7.62 mm machine gun with 200 rounds of linked ammunition. Two 80 mm GALIX combat vehicle protection system dischargers are mounted either side of the turret towards the rear and are electrically fired from within the vehicle. A total of 16 smoke rounds are normally carried with a loader unit as an optional extra.

For Operation Desert Shield/Desert Storm, the AMX-10RC vehicles of the French Army were upgraded, to include additional turret armour and thermal night vision equipment.

3

SPECIFICATIONS

CREW ARMAMENT

 1×105 mm gun 1×7.62 mm coaxial MG 4×80 mm GALIX dischargers

AMMUNITION $10\times105~\text{mm rounds} \\ 200\times7.62~\text{mm rounds}$

TRAVERSE $\begin{array}{c} 16 \times \text{GALIX smoke rounds} \\ 360^{\circ} \text{ powered/manual} \\ \text{ELEVATION} \\ \text{COMBAT WEIGHT} \end{array}$

Status: Production. In service with France, Morocco and Qatar.

Manufacturer: Giat Industries, 13 route de la Minière, 78034 Versailles Cedex, France.

Telephone: (1) 3097 3737 Fax: (1) 3097 3900



AMX-10RC (6×6) reconnaissance vehicle fitted with Giat Industries 105 TGG turret. This vehicle and turret also has additional armour for Operation Desert Storm

Giat Industries 105 TML Turret

Development

The TML family of modular turrets was developed by Giat Industries as a private venture for use either on new design, tracked or wheeled armoured vehicle chassis of 10-11 000 kg weight upwards or as part of a retrofit modernisation package.

Typical chassis on which the TML turret can be installed include the German Krauss-Maffei Puma armoured combat vehicle, the Giat AMX-10RC (6 × 6) and the Mécanique Creusot-Loire Industries MARS 15 family of light armoured vehicles. The modular construction allows turrets to be delivered according to the exact operational requirement of the customer.

Description

The three man power operated low profile turret is armed with a Giat Industries 105 mm G2 gun, which is ballistically identical to the 105 mm L7/M68 rifled tank gun but has a muzzle brake, thermal sleeve and integral fume extractor.

Two versions of the 105 mm G2 gun are offered: one, with a rifling of 32 turns at 7° 10' that, apart from standard NATO ammunition, can also fire the French HEAT round and, the other, with a 28 turn rifling at 9° 54' that fires the standard NATO 105 mm ammunition. Both versions have a vertical sliding breech mechanism angled 20° to the left. A total of 12 rounds of ready use ammunition are carried with the option of a revolving ammunition rack carried in the turret bustle.

Other types of 105 mm gun that can be installed include the French 105 mm F2 or the German Rheinmetall 105 mm Rh 105-20.



Giat Industries AMX-10RC chassis fitted with Giat Industries 105 TML turret

A 7.62 mm machine gun is mounted coaxial with the main gun and 14 GALIX grenade launchers, for smoke and anti-personnel grenades, are mounted singularly in sets of three or four on each of the four corners of the turret. A shield-mounted 7.62 mm machine gun can be fitted for close-in defence on the turret roof at the commander's station. As an option the 80 mm GALIX system can be replaced by the Ruggieri Capiro close-in vehicle defence system.

The standard TML turret configuration weighs 4600 kg including armament with the light armour plate alloy fit providing all-round protection from 14.5 mm fire. If, however, the customer requires a lighter turret then the armour protection package can be reduced.

The computerised fire control system fitted includes a SOPTAC telescopic sight for the gunner and an M389 panoramic sight for the vehicle commander. Optional fits include an image intensifier night vision system, a thermal imaging night vision system, raised observation cupola for the commander and a fire-on-the-move capability for the fire control system.

Various collective or individual NBC and integral intercom/FM radio communications fits are also available. The lateral external turret housings allow for extensive on-board kit and equipment stowage.

SPECIFICATIONS

CREW 3 (commander, gunner and loader) ARMAMENT 1 × 105 mm NATO gun G2 main coaxial 1 × 7.62 mm MG anti-aircraft (optional) 1 × 7.62 mm MG grenade launchers 14 × single Galix AMMUNITION (TURRET)

105 mm 12 7.62 n/av

CONTROL

360°, electrohydraulic with manual traverse

backup

-6° to +20°, electrohydraulic with manual depression/elevation

backup OPTICS see text LENGTH 7.815 m WIDTH 2.620 m HEIGHT with cupola 1.132 m without cupola 1.126 m

TURRET RING DIAMETER 2.14 m

DEPTH BELOW RING 0.88 to 1.0 m depending upon vehicle fit

WEIGHT

standard configuration 4600 kg

Status: Ready for production.

Manufacturer: Giat Industries, 13 route de la Minière, 78034 Versailles

Cedex, France

Telephone: (1) 3097 3737 Fax: (1) 3097 3900

Giat Industries TS 90 90 mm Turret

Development

The TS 90 modular/90 mm gun turret was revealed for the first time in 1977. It is suitable for use on any tracked or wheeled AFV weighing over 7500 kg and fires the same range of ammunition as the AMX-13 light tank armed with the 90 mm gun. The turret has so far been installed on the Panhard ERC 90 F4 Sagaie (6 × 6) armoured car, AMX-10 PAC 90 Fire Support Vehicle, AMX-10 RAC (6 × 6) armoured car, MOWAG Piranha (8 × 8) APC, ENASA BMR 600 (6 × 6) APC, MARS 15 light tank and the RVI VBC 90 armoured car.

In 1984 the turret was installed on an FMC M113 series APC for trials in the USA and this is now being offered for export. The TS 90 turret mounted on an LAV chassis was one of the contenders to meet the original US Marine Corps Assault Gun Vehicle requirement.

The turret is all-welded steel with the commander sitting on the left and the gunner on the right, both with an adjustable seat and a single-piece rearopening hatch. There is an extractor fan mounted in the roof.

Main armament consists of the long-barrelled 52-calibre 90 mm Giat Industries CN90 F4 gun of ESR steel with a 35° oblique wedge breechblock, hydro-pneumatic recoil system, thermal sleeve and a muzzle brake. A total of 20 rounds of ready-use ammunition are carried in the turret, four in the basket and 16 in the turret bustle. The empty cartridge cases are ejected into a bag under the breech and the commander is provided with an ammunition resupply hatch in the left side of the turret. Mounted coaxially to the left of the main armament is a 7.62 mm machine gun. Two electrically operated smoke dischargers are mounted either side of the turret towards

There are two white light searchlights, one mounted coaxially to the left of the main armament and a second in the forward part of the turret roof, operated by the commander.

The commander has seven (three M556 and four M554) periscopes and the gunner five (three M556 and two M554) and the gunner also has an M563 telescopic sight with a magnification of × 5.9 for laying the main armament.

Optional equipment includes: a 7.62 mm anti-aircraft machine gun; replacement of gunner's telescope by day/night telescope (day magnification 5 with a 10° field-of-view and night magnification × 7 with a 7° fieldof-view); a laser rangefinder; replacement of commander's forward periscope by a periscopic gunsight with a magnification of × 5 to enable the commander to aim and fire both main and coaxial weapons; number of smoke dischargers can be increased from four to six; 7.62 mm or 12.7 mm machine gun can be mounted on the roof of the turret for anti-aircraft defence; independent elevation of the coaxial 7.62 mm machine gun and the option of this machine gun being replaced by a 12.7 mm machine gun; electric traverse (360° in 14 seconds) and a fire control system.

Three fire control systems are currently offered by Giat Industries: installation of a TCV-107 laser rangefinder with ranges entered manually; automatically computed and displayed range/elevation corrections; and automatically computed and displayed elevation and lateral deflection corrections (with fitted azimuth tachometer and tilt sensor), so enabling moving targets to be successfully engaged.

Variants

The TS 90 F1 turret is fitted with the 90 mm Model 62 F1 gun, as installed in the Panhard AML armoured car fitted with the H 90 turret. The ammunition used by the F1 gun is shorter than the basic used by the TS 90 turret gun and so 40 rounds can be carried in the turret rather than 20, as in the case of the TS 90 with the long-barrelled gun. The TS 90 F1 turret can be fitted with the same optional equipment as the basic TS 90 turret.

The TS 90 turret is also used as the basis for the Giat Industries 81 mm TMC 81 turret fitted with the Thomson Brandt 81 mm CL81 smooth-bore gun/mortar described later in this section.

SPECIFICATIONS CREW

ARMAMENT

main secondary 2 (commander and gunner)

1 × 90 mm gun 1 × 7.62 mm MG or 1 × 12.7 mm MG AMMUNITION main, ready-use coaxial, ready-use 12.7 mm CONTROL traverse

xial, ready-use 2000 7 mm 500 NTROL verse 360° manual at 13°/s

> high speed and 5°/s low speed

-8° to +15° manual

at 1.5°/s

OPTICS
commander 7 periscopes
gunner 5 periscopes
telescopic sight

WEIGHT (fully equipped) 2650 kg

Status: In production. In service with a number of countries including France (Army and Gendarmerie), Indonesia, Ivory Coast, Oman, Saudi Arabia and Singapore.

Manufacturer: Giat Industries, 13 route de la Minière, 78034 Versailles Cedex. France.

Telephone: (1) 3097 3737 Fax: (1) 3097 3900

Panhard ERC Sagaie 1 (6 × 6) armoured car fitted with the TS 90 turret



SAMM TTB 190 90 mm Turret

Development

The TTB 190 90 mm two-man turret has been developed as a private venture by SAMM and was shown for the first time in June 1983. Development of the TTB 190 turret was completed in 1985 and production began later the same year. First production turrets were fitted to Sagaie 2s ordered by Gabon.

Description

The turret is of all-welded steel construction with the commander sitting on the left and the gunner on the right, both with a single-piece hatch cover opening to the rear.

Frontal armour provides protection against 12.7 mm armour-piercing rounds at 100 m; the remainder is protected against 7.62 mm armour-piercing rounds at 100 m and 155 mm air burst shell splinters at 30 m. Standard turret equipment includes a ventilator for removing fumes, ceiling lights, adjustable seats and three-position roof hatches.

The main armament of the TTB 190 turret is a Giat Industries 90 mm CS 90 F4 gun with a 7.62 mm machine gun mounted coaxially to the left and a similar weapon mounted on the commander's cupola. As an option the coaxial 7.62 mm machine gun can be replaced by a 12.7 mm weapon.

Mounted either side of the turret are four Wegmann smoke/fragmentation launchers, or two French 80 mm smoke grenade launchers, or the new Galix system.

Two types of 90 mm ammunition stowage are available. The first has a total of 35 rounds of which 13 are in the turret for ready-use and the remaining 22 in the turret rack at the rear. The other model has a total of 32 rounds, 10 of which are for ready-use (eight in a drum magazine) and the remaining 22 in the turret rack at the rear.

Turret traverse and weapon elevation are electric with the SAMM 06 system installed. Maximum traverse speed is 35°/s and maximum elevation speed is 14°/s. The commander has a cupola with seven periscopes for all-round observation. For his main sight there is a choice of either the P204

day/night for aiming and firing the gun with a fire control console. This has magnifications of \times 8 (day) and \times 8 (night) for aiming and a day periscope which can be elevated with the main armament from -8 to $+15^\circ$; or the SFIM VS580 panoramic gyro-stabilised day/night sight with full onthe-move observation capabilities using a \times 3/× 10 interchangeable day channel and \times 8 night channel. To reduce the engagement time the main armament is fitted with a two-axis servo-drive unit which automatically aligns the gun to the line-of-sight of the VS580.

The gunner has an LRS5 NG gun sight which includes a telescopic day sight with a magnification of \times 8, telescopic night sight with a magnification of \times 6, standard day periscope, laser rangefinder and a digital computer.

SPECIFICATIONS

commander

CREW	2 (commander and qunner)
ARMAMENT	50
main	$1 \times 90 \text{ mm gun}$
coaxial	1×7.62 mm or
	12.7 mm MG
anti-aircraft	1 × 7.62 mm MG
AMMUNITION	
90 mm	32 or 35
7.62 mm	3000
CONTROL	
traverse	360° (35°/s electric)
elevation	-8° to +15°
	(14°/s electric)
OPTICS	

P204 sight with magnification of × 8 (day) and × 8 (night), or VS580 sight with magnifications of × 3/× 10 (day) and × 8 (night) 7 observation periscopes sight with magnification of × 8 (day) and × 6 (night),

gunner sight with magnification of × 8 (day) and × 6 (night) 3 observation periscopes

WEIGHT 2800 to 3200 kg

DIMENSIONS

Jenoth overall 6.81 m.

DIMENSIONS
length overall 6.81 m
width overall 2 m
height inc AA MG 1.236 m
height inc periscopes 0.966 m
height above
hull top 0.609 m
depth below
turret ring 0.819 m



SAMM TTB 190 turret installed on Panhard ERC Sagaie 2 (6 \times 6) armoured car

Status: Production as required (six produced to date - 1 January 1993). In service with Gabon on Panhard ERC Sagaie 2 (6×6) armoured car.

Manufacturer: Société d'Applications des Machines Motrices, Chemin de la Malmaison, 91570 Bièvres, France.

Telephone: 33 (1) 69 35 80 00 Telex: 933-1 69 41 15 72 Fax: 33 (1) 69 35 81 98

Hispano-Suiza Lynx 90 Turret

Development/Description

The Lynx 90 turret has been developed from the earlier H 90 turret, of which more than 2000 were built, and is suitable for a variety of tracked and wheeled vehicles such as the Panhard AML (4 \times 4) and the Panhard ERC (6 \times 6) armoured cars. The all-welded steel turret armour varies in thickness from 8 to 15 mm. The commander sits on the left of the turret and the gunner on the right, both with a single-piece hatch cover and an adjustable seat. A ventilator is mounted in the turret roof at the rear and standard equipment includes turret lighting.

The commander has a raised rotating cupola for all-round observation on which a 7.62 mm machine gun can be pintle-mounted for anti-aircraft

defence if required. A white light spotlight is mounted coaxially with the 90 mm D921 gun and a laser rangefinder such as the French TCV 107 is mounted over the main armament just in front of the mantlet. Optional equipment includes: storage racks; external stowage box; various types of SOPELEM fire control systems; passive night vision equipment for the commander and gunner; electromechanical or electrohydraulic traverse and elevation in place of the manual controls; traverse indicator and 90 mm Cockerill Mark III gun with a maximum elevation of +30°.

Variants

In June 1983 the Lynx 75/90 turret was announced. This can be fitted with a 90 mm Cockerill Mk III gun or other 75 mm or 90 mm guns, or a Thomson Brandt breech-loaded mortar. Optional equipment includes a day/night sight, laser rangefinder and powered controls.

SPECIFICATIONS CREW ARMAMENT	2 (commander and gunner)	OPTICS commander	8 L794 periscopes in cupola and optional passive periscope as
main	1 × 90 mm gun (D921 or Cockerill Mark III) 1 × 7.62 mm MG (AA 52 or MAG 80)	gunner	replacement for one of day periscopes 4 L794 periscopes plus day sight, latter can be replaced by
anti-aircraft optional AMMUNITION	1 × 7.62 mm MG (AA 52 or MAG 80)		SOPELEM day/night telescope model TJN 2-90B
(ready-use in turret)		WEIGHT	
90 mm	21	(including crew and	
7.62 mm	2000	ammunition)	1950 to 2200 kg
SMOKE DISCHARGERS	2 × 2 or 2 × 3 or	DIAMETER (at base)	1.499 m
	4 × 3 (Wegmann) or	SWEPT RADIUS	
CONTROL	4 × 4 (Wegmann)	(gun and turret) LENGTH OVERALL	3.4 m
traverse	360° manual in 30 s	WIDTH OVERALL	4.892 m 1.656 m
liaveise	360° electrohydraulic	HEIGHT	1.030 111
	in 8 s	above vehicle roof	
elevation	-8° to +35°	without AA MG	0.696 m
	(standard)	above vehicle roof	
	-8° to +20°	with AA MG	0.996 m
	(optional)	POWER SUPPLY	24 V
	(or +30° Cockerill		
2.0216	Mk III) 25° (powered)		
cupola	rotating independently and manually		

Status: Production. In service with the French Army (on Panhard chassis) and countries in Africa, the Middle East and South America.

Manufacturer: Hispano-Suiza, 333 Bureaux de la Colline, F-92213, Saint-

Cloud Cedex, France

Telephone: (1) 46 02 70 65 Telex: 203 945



Lynx 90 turret with 90 mm D921(F1) gun on Mexican Army Panhard ERC 90 Lynx (6×6) armoured car

Giat Industries 81 mm Gun-Mortar Turret (TMC 81)

Development/Description

Shown for the first time at the 1981 Satory Exhibition of Military Equipment, the Giat Industries Gun-Mortar Turret was fitted with the Thomson Brandt CL81 smooth-bore mortar. The turret was fitted to an AMX-10P chassis and an RVI VBC 90 (6×6) chassis, with the former designated the AMX-10 TMC 81.

The two-man turret is a further development of the Giat Industries TS 90

90 mm turret with the latter being replaced by an 81 mm smooth-bore mortar with an elevation of $+66^{\circ}$ and a depression of -7° . The semi-automatic breech-loaded mortar has a maximum rate of fire of 10 rds/min and can be used for both direct and indirect fire.

When the turret is fitted to the AMX-10P 108 rounds of HE are carried, with a maximum range of 7500 m and a muzzle velocity of 400 m/s. In addition, 10 APFSDS rounds are carried, with a muzzle velocity of 1000 m/s and an effective range of 1200 m.

A 7.52 mm or 12.7 mm M2 HB anti-aircraft machine gun is mounted on the turret roof and three or four electrically operated smoke dischargers are mounted either side of the turret.

The fire control system includes a computerised cant corrector. Turret observation equipment consists of an M411 periscopic aiming sight and 11 periscopes for all-round observation.

SPECIFICATIONS

CREW ARMAMENT

main

anti-aircraft smoke dischargers AMMUNITION 81 mm

CONTROL depression/elevation

traverse **OPTICS**

BALL BEARING RACE DIAMETER **OVERALL LENGTH OVERALL HEIGHT** WEIGHT (total)

2 (commander and gunner)

1 × 81 mm MCB81 semiautomatic breach loading mortar

1 × 7.62 or 12.7 mm MG 2×3

10 manual

-7° to +66° (optional electrical aiming available)

360°

1 × M411 aiming periscope 11 x unity periscopes

4.232 m 1.92 m 2700 kg Status: Development complete. Ready for production.

Manufacturer: Giat Industries, 13 route de la Minière, 78034 Versailles Cedex, France.

Telephone: (1) 3097 3737 Fax: (1) 3097 3900



RVI VBC 90 fitted with Giat Industries 81 mm turret (Christopher F Foss)

Giat Industries 81 mm Mortar Turret (TMR 81)

Development/Description

Shown for the first time at the 1990 Satory Exhibition of Military Equipment was the Giat Industries TMR 81 one-man turret fitted with a Giat Industries quick firing 81 mm mortar mounted on an AMX-10P APC. The turret is designed for installation on tracked or wheeled light armoured vehicles as an indirect fire support weapon.

The 81 mm mortar model used has a recoiling barrel and sliding mass that allows a maximum rate of fire of 5 rounds in 4 seconds. All 81 mm mortar ammunition under 512 mm in length can be fired. The loader and ammunition are carried in the main hull of the vehicle.

Target observation is by episcopes and a transparent dome fitted into the gunner's hatch. Target aiming is manual for weapon elevation (±38° to +83°) and azimuth (±30° depending upon vehicle chassis). The onboard fire control system has automatic correction for weapon inclination.

Operations with the turret can be carried out in an NBC contaminated environment

SPECIFICATIONS

CREW ARMAMENT **OPTICS** TURRET BASKET diameter

height TRAVERSE DIAMETER WEIGHT (loaded)

1 × 81 mm mortar

episcopes plus transparent dome

1.3 m 1.278 m 1560 kg

Giat Industries TMR 81 mortar turret on AMX-10P chassis

Status: Prototype.

Manufacturer: Giat Industries, 13 route de la Minière, 78034 Versailles Cedex, France. Telephone: (1) 3097 3737 Fax: (1) 3097 3900

Hispano-Suiza H 60 Series of Turrets

Development

The H 60 series of turrets was originally designed for the Panhard AML (4 × 4) armoured car which entered service with the French Army in 1961, but it is suitable for a wide range of light AFVs. So far well over 1600 H 60 series turrets have been built. There are two basic models: H 60-7 armed with a 60 mm mortar and two 7.62 mm machine guns and H 60-12 armed with a 60 mm mortar and a 12.7 mm (0.50) M2 HB machine gun. Two types of 60 mm mortar can be fitted: the 60 CS DTAT or the Thomson Brandt HB 60 and, in addition to the basic versions of the turret, command models with additional communications equipment and less ammunition are available.

The 60-20 turret armed with a 60 mm mortar and a 20 mm cannon has been replaced in production by the Serval 60/20 turret, for which there is a separate entry.

Description

The turret is of cast and welded construction with the commander seated on the left and the gunner on the right, both with an adjustable seat. Over the top of the turret is a two-piece hatch cover that opens front and rear. A searchlight mounted on the turret roof can be operated by the commander from inside. A second searchlight on the forward part of the turret moves in elevation with the armament. Standard equipment includes a turret ventilator, lights and a stowage rack on the turret rear. If required a 7.62 mm antiaircraft machine gun can be mounted on the turret roof.



Panhard AML (4 × 4) armoured car fitted with H 60 series turret armed with 60 mm mortar and twin 7.62 mm machine guns

Status: Production as required. In service with many armed forces.

Manufacturer: Hispano-Suiza, 333 Bureaux de la Colline, F-92213, Saint-Cloud Cedex, France

Telephone: (1) 46 02 70 65 Telex: 203 945

AMMUNITION SWEPT RADIUS **SPECIFICATIONS** CREW 2 (commander and command combat (gun and turret (60-7)) 1.393 m HEIGHT aunner) version version ARMAMENT 31 × 60 mm 43 × 60 mm to top above hull 0.402 m 60 mm Thomson Brandt 3200 × 7.62 mm 3800 × 7.62 mm to top of searchlight main 900 × 12.7 mm 1300 × 12.7 mm 0.735 m HB 60 mortar above hull OPTICS POWER SUPPLY 2 × 7.62 mm or 24 V secondary 1 × 12.7 mm MG commander 4 periscopes CONTROL gunner 3 periscopes M 112/3 sight 360° manual at 25°/s traverse WEIGHT

DIAMETER (at base)

1180 kg

1.48 m

Hispano-Suiza Serval 60/20 Turret

Development

elevation

This is the latest turret in the extensive Hispano-Suiza 60 series range and is in production for the Panhard ERC (6 \times 6) and Panhard AML (4 \times 4) armoured cars. The turret is also suitable for a wide range of other tracked and wheeled AFVs such as the M113 APC and has also been fitted to the Vickers Valkyr (4 × 4) armoured personnel carrier.

manual -15° to +80°

mortar -15° to +60° MGs

Description

The turret is all-welded with armour varying in thickness from 8 to 15 mm. The commander sits on the left with the gunner on the right, each with a single-piece hatch cover that opens to the rear and an adjustable seat.

Armament is a 60 mm breech/muzzle-loaded mortar, a 20 mm automatic cannon mounted externally at the rear of the turret and a 7.62 mm machine gun mounted coaxially with the 20 mm cannon. The 60 mm mortar can be either the HB 60 short-range (maximum direct fire range of 500 m and 2600 m for indirect fire) with 50 mortar bombs in the turret or the HB 60 long-range with a maximum direct fire range of 1000 m with APFSDS projectiles, and a maximum indirect fire range of 5000 m with LPED projectiles. The 20 mm cannon can be either a French M693 dual-feed cannon with '300 rounds of high-explosive and 37 rounds of armour-piercing ammunition for ready-use or an HS 820 (Oerlikon-Contraves KAD-B16) single-feed cannon with 300 rounds of ready-use ammunition. The 7.62 mm machine gun has 200 rounds of ready-use ammunition and 400 rounds in reserve.

Standard equipment includes a spotlight mounted coaxially with the 7.62 mm machine gun, internal lighting and a ventilation fan mounted in the rear of the turret. Optional equipment includes an NBC system, laser rangefinder, SOPELEM 26 fire control system with calculator, cant corrector, elevation meter and an electromechanical or hydraulic turret traverse system (360° traverse in 7.5 seconds).



Hispano-Suiza Serval 60/20 turret on Panhard AML (4 x 4) armoured car

Status: Production as required.

Manufacturer: Hispano-Suiza, 333 Bureaux de la Colline, F-92213, Saint-Cloud Cedex, France

Telephone: (1) 46 02 70 65 Telex: 203 945

SPECIFICATIONS . CREW	2 (commander and gunner)	OPTICS commander gunner	7 periscopes 2 periscopes	SWEPT RADIUS (gun and turret) LENGTH	1.789 m
ARMAMENT	1 × 60 mm mortar 1 × 20 mm cannon 1 × 7.62 mm MG		sight (magnification × 1 and × 6) with range scales	overall turret HEIGHT	2.824 m 1.712 m
SMOKE DISCHARGERS CONTROL traverse	2 each side of turret 360° manual in 30 s		corresponding to 3 weapons and direct anti-aircraft sight	(above vehicle roof) WIDTH POWER SUPPLY	0.9 m 1.656 m 24 V
elevation	manual, mortar –8° to +80°, cannon and MG –8° to +50°	WEIGHT (depending on armament) DIAMETER (at base)	1600-1800 kg 1.499 m		

Hispano-Suiza Mangouste 60 mm/12.7 mm Turret

Development

This turret was announced in 1983 and is based on the Lynx 90 turret fully described earlier in this section. It can be installed on any vehicle weighing over 5 tonnes, including the Panhard AML (4 × 4) light armoured car.

The turret is of all-welded steel armour varying in thickness from 8 to 15 mm. The commander sits on the left and the gunner on the right, each with a single-piece hatch cover opening to the rear and an adjustable seat. A ventilator is mounted in the turret roof at the rear and standard equipment includes turret lighting. The commander has a raised cupola for all-round observation on which a 7.62 mm machine gun is pintle-mounted for antiaircraft fire. A white light searchlight is mounted coaxially with the 12.7 mm machine gun.

Main armament is a Thomson Brandt HB 60 LP mortar (range 500 to 5000 m) which also fires an armour-piercing round, with a 12.7 mm M2 HB heavy machine our mounted to the left with independent elevation and depression

The gunner's M371 sight has magnifications of \times 1 and \times 6 and a collimator for anti-aircraft fire. This can be replaced by a day/night sight or a SOPTAM day/night sight with an associated fire control system. The commander can have his forward periscope replaced by a SOPELEM night periscope model CN 2-508.

Optional equipment includes a storage rack, external stowage racks and power traverse

Status: Ready for production.

Manufacturer: Hispano-Suiza, 333 Bureaux de la Colline, F-92213, Saint-

Cloud Cedex, France.

Telephone: (1) 46 02 70 65 Telex: 203 945



Hispano-Suiza Mangouste 60 mm/12.7 mm turret showing independent elevation of weapons

SPECIF	ICAT	IONS
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CREW

ARMAMENT

SMOKE DISCHARGERS

2 (commander and gunner) 1 × 60 mm mortar 1 × 12.7 mm MG

1 × 7.62 mm MG 2 each side of

turret

AMMUNITION 60 mm

12.7 mm

7.62 mm OPTICS commander

aunner

65 (30 for emergency use) 1200

800

8 periscopes 4 periscopes 1 M371 sight CONTROL traverse

elevation, 60 mm mortar elevation, 12.7 mm MG LENGTH OF TURRET WIDTH OF TURRET

HEIGHT (to top of commander's cupola above hull top) DEPTH (below hull top)

0.755 m 0.825 m

360° manual -12° to +85° manual -12° to +55° manual 3.29 m

1.656 m

Mécanique Creusot-Loire CB 60 HB Shield Gun Racer for 60 mm Mortar

Development/Description

The Mécanique Creusot-Loire CB 60 HB shield gun racer for a 60 mm Thomson Brandt mortar has been designed for light AFVs. It consists of three main parts: baseplate, rotating mount and the tilting part.

The base gun-ring is attached to the top of the hull by 22.9 mm bolts and supports the traversing gun-ring, the bearing and the electrical power supply tracks. The rotating mount consists of the shield which is fitted with the gunport supporting the weapon, cradle trunnions and elevation laying quadrant, two semi-circular doors which provide side protection to the gunner when open, opening and locking devices for the doors, elevating lock, traversing mechanism and an electrical control and junction console.

The tilting part consists of the cradle weapon support, weapon and cradle balancing device, manual elevating controls with handgrip electric firing system and the x 3 magnification sight. The gunner uses his left hand for laying the weapon in elevation and his right hand for laying it in traverse. The mortar-ring shield has a slant correction device and can be fitted with an infra-red searchlight.

Status: In production.



Thomson Brandt 60 mm mortar mounted on Panhard M3 (4 × 4) APC

Manufacturer: Giat Industries/Mécanique Creusot Loire, 13 route de la Minière, 78034 Versailles Cedex, France

Telephone: (1) 3097 3737 Fax: (1) 3097 3900

SPECIFICATIONS

CREW

ARMAMENT

CONTROL

traverse

elevation

1 (gunner)

1 × 60 mm Thomson Brandt breech-

-15° to +75° manual

or muzzleloaded mortar

360° manual

weapon

WEIGHT

with weapon and gun port DIAMETER OF APERTURE

REQUIRED IN VEHICLE

gun racer without

ROOF

HEIGHT ABOVE VEHICLE

ROOF (including searchlight) WIDTH OVERALL

POWER SUPPLY

0.82 m 1.2 m 24 V

0.705 m

270 kg

350 kg

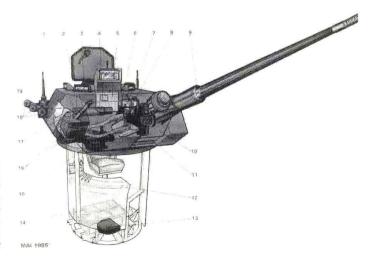
Giat Industries 25 mm DRAGAR Turret

Development

This one-man turret has been developed by Giat Industries and was first shown at the 1983 Exhibition of Army Weapons and Equipment held at Satory, where it was installed on an AMX-10P ICV. The turret has been designed for installation on any tracked or wheeled vehicle with a hole diameter of 1100 mm and a depth of 1 m and can be used to engage both air and ground targets out to 2000 and 1500 m respectively.

The DRAGAR turret has been sold to Turkey for use on the FMC-NUROL AIFV, and to Singapore for its new Giat Industries AMX-10P Marine vehicles.

The DRAGAR Turret (1) equaliser battery (2) 7.62 mm machine gun (3) M223 episcopes (4) gyrometer box (5) TJN2-71C daylight sight (6) radio-intercom case (7) gyrometer panel (8) control panel (9) Giat Industries 25-M811 25 mm cannon (10) armoured shield (11) laying, electric and manual elevation (12) ammunition case (13) electric swivel joint (14) turret servo/control system box (15) laying, electric and manual bearing (16) flexible ammunition-feed guides (17) armour-piercing ammunition container (18) 6 GALIX launchers (close protection) (19) twin-plated armour shield



Description

The turret is of all-welded construction with the dual-feed Giat Industries 25-M811 cannon in the forward part of the turret on the left and the coaxial 7.62 mm machine gun on the right. Turret traverse and weapon elevation are electric and if required a stabilisation system can be fitted as an extra. A belt stopping system stops the firing so that the next belt can be connected without having to reload the weapon. Mounted either side the turret is a bank of three GALIX type grenade launchers.

The gunner has a roof-mounted periscope with a dual day channel magnification of \times 1 (31° field-of-view) and \times 7 (7° field-of-view) and a light intensified night channel with an 800 m range, a \times 4 magnification and 10 $^{\circ}$ field-of-view, two M223 roof-mounted observation periscopes either side of the roof hatch and two vision blocks in the turret rear.

Optional equipment includes: a day/night thermal vision camera; laser rangefinder; thermal camera allowing targets to be detected at a range of 2000 m; turret stabilisation system; simplified fire control allowing firing on mobile targets; simplified fire control allowing automatic weapon firing; complete protection against 7.62 mm ammunition at all ranges; artillery shell splinters from 20 m; 12.7 mm ammunition from 500 m and 14.5 mm ammunition from 1000 m; installation of radio set in turret; and fitted spotlight on the turret.

SPECIFICATIONS

CREW ARMAMENT main coaxial smoke dischargers 2×3

AMMUNITION 25 mm 7.62 mm CONTROL

traverse elevation/depression **OPTICS**

WEIGHT (loaded)

1 × 25 mm cannon 1 × 7.62 mm MG

220 (173 HE, 45 AP)

200 round box (interchangeable) electrical/manual backup 360°

-8° to +45° 4 × M223 periscopes 2 x rear unity vision blocks

1 × day/night sight

1250 kg

Status: In production. In service with Turkey and Singapore.

Manufacturer: Giat Industries, 13 route de la Minière, 78034 Versailles

Cedex, France

Telephone: (1) 3097 3737 Fax: (1) 3097 3900



Giat Industries 25 mm DRAGAR turret showing 7.62 mm machine gun mounted to right of turret

Mécanique Creusot-Loire T.25 Turret

Development/Description

CDECIEICATIONS

This two-man turret, designed as a private venture by Mécanique Creusot-Loire for installation on light armoured vehicles, was announced in 1983. For trials purposes this has been installed on a number of vehicles including the AMX-13 VCI tracked IFV, the MARS 15 IFV and the Panhard AML (4 × 4) armoured vehicle.

The turret, which is of all-welded steel construction, consists of two main parts: the fixed part which is attached to the vehicle by 36 bolts and the revolving part. The latter includes the mobile bearing race and the turret itself with two roof hatches, the commander located on the left and the gunner on the right. Turret traverse and weapon elevation are electric with manual backup for both functions. The turret basket includes two adjustable seats, two 25 mm ammunition boxes and one electric control panel. The oscillating part includes a cylindrical shield which enables the empty cartridge cases to be ejected outside the vehicle. It also includes the weapon cradle and the 7.62 mm ammunition box. Manual controls are also provided and the commander can override the gunner.

The turret has been designed to engage ground targets (and aerial targets in self-defence), and is usually armed with the Giat Industries 25 mm M811 cannon. A 7.62 mm machine gun is mounted coaxially with the main armament. Mécanique Creusot-Loire intends to install a 30 mm cannon in the T.25 turret for trials as well as the 23 mm former Soviet cannon.

(interchangeable)



Mécanique Creusot-Loire T.25 turret armed with 25 mm cannon and coaxial 7.62 mm machine gun installed on the Mécanique Creusot-Loire MARS 15 Infantry Fighting Vehicle

SPECIF	-ICATIONS		CONTROL	
CREW		2 (commander and	traverse	360
		gunner)	elevation	-8° to +55°
ARMAN	MENT		OPTICS	2 day or day/night
main		1 × 25 mm cannon		(image intensifier)
coaxial		1 × 7.62 mm MG		sights with \times 1, \times 6.8
IUMMA	NITION			and × 4 magnification
25 mm		215-260 rounds		10 periscopes
		(depending on type	DIAMETER OF HOLE	
		of cannon installed)	REQUIRED IN	
7.62 mi	m	200-round box	VEHICLE ROOF	1.515 m

CONTROL

WEIGHT WITH WEAPONS	
AND AMMUNITION	1350 kg
LENGTH OVERALL	3.66 m
HEIGHT ABOVE VEHICLE	
ROOF (excluding	
periscopes)	0.52 m
DEPTH BELOW VEHICLE	
ROOF	0.965 m
AXIS OF FIRE ABOVE	
VEHICLE ROOF	0.255 m
WIDTH	1.852 m

Status: Pre-production.

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la

Minière, 78034 Versailles Cedex, France. Telephone: (1) 3097 3737 Fax: 3097 3900

Mécanique Creusot-Loire T.20 Turret

Development

This one-man turret has been designed and built as a private venture and can be installed on a wide range of light tracked and wheeled armoured vehicles. It can be used to engage both ground and aerial targets.

Description

The Mécanique Creusot-Loire T.20 turret consists of four parts: the fixed part, rotating part, basket and oscillating part. The fixed part is attached to the vehicle and consists of a fixed bearing race with a traverse gun ring. The rotating part is made of all-welded steel and bears the mobile bearing race.

The turret is electrically powered in both traverse and elevation with a manual backup. The turret basket contains the adjustable gunner's seat, removable 20 mm ammunition box, electric belt end control system, the hydraulic system providing belt linking and gun re-arming, the electronic control box and slip ring. The oscillating part contains the weapon cradle and the 7.62 mm ammunition box, an optional searchlight fitted over the weapons and a gun sight.

Main armament consists of a Giat Industries 20 mm M693 cannon with a 7.62 mm machine gun mounted coaxially to the right. Standard equipment includes two interior dome lights and a fume extraction fan. Optional equipment includes: smoke dischargers; searchlight; air defence firing aid; night firing sight.



Mécanique Creusot-Loire T.20 turret

Status: In production. In service in Cyprus (on Renault VAB chassis).

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la Minière, 78034 Versailles Cedex, France.
Telephone: (1) 3097 3737 Fax: (1) 3097 3900

SPECIFICATIONS CREW	1 (gunner)	CONTROL (powered/manual) traverse	360° -8° to +55°	HEIGHT OF TURRET (above hull roof)	0.531 m
ARMAMENT main	1 × 20 mm	elevation OPTICS	one sight with \times 6	HEIGHT (including periscopes)	0.597 m
	cannon		magnification	WIDTH OF TURRET	1.41 m
coaxial	1 × 7.62 mm GPMG	WEIGHT (with weapons	4 periscopes	DEPTH OF TURRET (below hull roof)	0.95 m
AMMUNITION		ammunition and gunner)	1020 kg	AXIS OF FIRE	
20 mm ready-use	130	SWEPT RADIUS	2.1 m	(above hull roof)	0.193 m
7.62 mm ready-use	200		-	POWER SUPPLY	24 V

Giat Industries 20 mm CAPRE Turret

Development/Description

This is a further development of the Giat Industries 20 mm CAPRE 20 turret first shown in 1981.

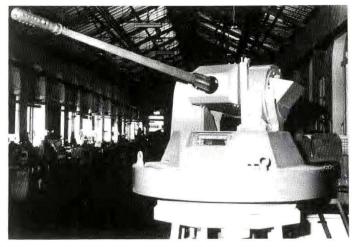
The Giat Industries 20 mm CAPRE turret uses the same 830 mm diameter ball race mounting as the Toucan I described in the following entry.

Main armament comprises an externally mounted 20 mm Giat Industries F2 cannon with 105 rounds of ready-use ammunition (60 rounds in magazine and 45 rounds in chute) and a 7.62 mm machine gun with 250 rounds of ready-use ammunition mounted above. The turret armour provides protection against attack from 7.62 mm ammunition at any range and against 14.5 mm ammunition at a range of 1000 m.

The gunner aims the weapons while sitting in the safety of the vehicle using an M371 periscopic sight with a magnification of \times 6 and a 10° field-of-view, \times 1 with 71 \times 26° field-of-view, four periscopes with two in either side of the forward part of the turret, a vision block in the turret rear and a searchlight that moves in elevation with the weapons. Turret traverse and weapon elevation are manual. Five periscopes give observation to the sides and rear of the turret.

Optional equipment includes: a searchlight mounted coaxially with 20 mm cannon; two electrically operated smoke dischargers either side of the 20 mm cannon; installation of a TJN2 71 day/night sight; simplified day sight; stabilised day sight; and powered traverse and elevation.

Status: In service with the French Army.



20 mm CAPRE one-man turret

Manufacturer: Giat Industries, 13 route de la Minière, 78034 Versailles Cedex, France.

Telephone: (1) 3097 3737 Fax: (1) 3097 3900

SPECIFICATIONS CREW ARMAMENT	1 (gunner) 1 × 20 mm cannon 1 × 7.62 mm MG	CONTROL traverse elevation OPTICS	360° manual -8° to +45° manual	HEIGHT OF TURRET ABOVE RING WIDTH OF TURRET SWEPT RADIUS OF	0.875 m 1.22 m
AMMUNITION		sight	× 6 magnification	TURRET	1.95 m
20 mm	105	periscopes	5	AXIS OF FIRE ABOVE	
7.62 mm	250	WEIGHT (with ammunition)	700 kg	TURRET RING	0.66 m

Giat Industries Toucan I Turret

Development

The one-man Toucan I turret, designed by Giat Industries for installation on most types of APC currently in service, is already standard on the AMX-10 ECH repair vehicle and the AMX-10 TM mortar tractor. The turret has also been fitted on the AMX VCI, Panhard M3 (4 \times 4) and VCR/TT (6 \times 6), M113 and Renault VAB (6×6) vehicles. The Toucan I turret is also known as the T 20.13.

Description

The turret is armed with a 20 mm M693 dual-feed cannon fed from one magazine holding 75 rounds of HE ammunition and another holding 45 rounds of armour-piercing ammunition, or an M621 single-feed cannon, fed from a magazine holding 96 rounds of ammunition. A belt stop prevents the ammunition supply running out prior to belt renewal. The turret can also be fitted with other types of 20 mm cannon such as the German Rh 202 or the Swiss HS 804 or HS 820. A 7.62 mm machine gun can be mounted coaxially with the 20 mm cannon fed from a box holding 200 rounds of ammunition.

The armament has an elevation of +50° and a depression of -13° with turret traverse being a full 360°. The basic model is manually operated but an electric power traverse system can be fitted as an option, enabling the turret to be rotated at a maximum speed of 37°/s.

There are two basic models of the Toucan I turret: the model A, or heavy model, which has a steel race ring providing maximum possible armour protection, or a light alloy model which is known as the model B, or light model. The turret can be delivered without the basket, power supply ring or smoke dischargers mounted two either side of the forward part of the turret.

Vision equipment consists of six periscopes, a day sight with magnifications of x 1 and x 6, reflex anti-aircraft sight and an open sight for direct fire. The day sight can be replaced by an APX M493 periscopic sight with magnifications of \times 1 (day), \times 6 (10° field-of-view, day) and \times 4.5 (night).



Giat Industries Toucan I turret on member of AMX-10P family

The main sight can also be fitted with a washer and wiper. A spotlight can be mounted coaxially with the 20 mm cannon. Two types are available, BBT with a maximum range of 400 m or the PH 9A with a maximum range of 1000 m

Status: In production. In service with French and other armies.

Manufacturer: Giat Industries, 13 route de la Minière, 78034 Versailles Cedex. France.

Telephone: (1) 3097 3737 Fax (1) 3097 3900

SPECIFICATIONS

CREW ARMAMENT

SMOKE DISCHARGERS **AMMUNITION**

20 mm, ready-use

7.62 mm, ready-use

1 (gunner)

1 × 20 mm cannon 1 × 7.62 mm MG

2 either side of turret (optional)

120 (dual-feed cannon) 96 (single-feed cannon)

200

CONTROL traverse elevation

OPTICS

360° manual at 12°/s

-13° to +50° manual at 16°/s 6 periscopes day sight reflex sight

open sight

WEIGHT

650 kg without ammunition, type A without ammunition, type B 550 kg 698 kg with ammunition, type A with ammunition, type B 598 kg HEIGHT (above vehicle roof)

0.71 m

Giat Industries Toucan II Turret

Development

The two-man Toucan II turret was designed by Giat Industries for the AMX-10P IFV which is in service with France, Greece, Qatar, Saudi Arabia and the United Arab Emirates. It is suitable for other AFVs including the M113A1, the Cadillac Gage Commando V-150 and the FIAT 6616.

Description

The gunner is seated on the left and the commander on the right, both with an adjustable seat and a single-piece hatch cover that opens to the outside. The commander has an M371 sight with magnifications of \times 1 and \times 6, a direct sight for anti-aircraft use and an external sight for direct fire. The gunner has an OB 40 day/night periscope with a day magnification of × 6 (10° field-of-view) and a night magnification of \times 5 (7° field-of-view). The gunner's OB 40 sight can be replaced by an M406 day sight with magnifications of × 2 and × 6 or an OB 37 image intensification sight with a

aunner)

325

200

magnification of × 6. The commander and gunner have seven periscopes for all-round observation. Turret traverse is electric by either the commander or the gunner. In the event of a power failure the gunner traverses the turret with manual controls.

The 20 mm M693 dual-feed cannon is mounted externally on the left side of the turret and is provided with 260 rounds of HE and 65 rounds of readyuse armour-piercing ammunition. A belt stop prevents the ammunition supply running out prior to belt renewal. The empty cartridge cases are ejected externally from the turret. Mounted coaxially above and to the right of the 20 mm cannon is a 7.62 mm machine gun, which has 200 rounds of ready-use ammunition. Mounted coaxially with the 20 mm cannon is a 7.62 mm machine gun, a PH 9A searchlight and, mounted on either side of the turret, two electrically operated smoke dischargers.

The turret can be delivered with the 20 mm M693 cannon replaced by other 20 mm cannon including the French M621, German Rh 202 and the Swiss HS 804 or HS 820, and with the smoke dischargers removed. Other types of vision equipment can also be fitted.

SPECIFICATIONS CREW

ARMAMENT SMOKE DISCHARGERS **AMMUNITION**

(ready use in turret) 20 mm 7.62 mm

CONTROL 2 (commander and traverse

1 × 20 mm cannon 1 × 7.62 mm MG elevation 2 either side of turret

OPTICS

360° electric at 50°/s powered and 10°/s manual -8° to +50° electric at 30°/s powered and 26°/s manual 7 periscopes M371 sight OB 40 sight

WEIGHT with guns but without ammunition

including guns and ammunition POWER SUPPLY

1165 kg

1312 kg 26 V

Status: In production. In service with France, Greece, Qatar, Sauda Arabia and the United Arab Emirates.

Manufacturer: Giat Industries, 13 route de la Minière, 78034 Versailles Cedex, France.

Telephone: (1) 3097 3737 Fax: (1) 3097 3900



Giat Industries Toucan II turret on AMX-10P IFV

SAMM TAB 220 20 mm Anti-aircraft Turret

Development

This two-man anti-aircraft turret was previously known as the S 530 F and was shown for the first time in 1983. It is suitable for installation on a wide range of tracked and wheeled armoured vehicles and has already been installed on the Panhard ERC (6 \times 6) armoured car. This combination is designated Panhard ERC 20 Kriss.

Description

The turret is of all-welded steel construction with a uniform armour thickness of 8 mm. The gunner sits on the right and the commander on the left. The gunner has a single-piece hatch cover opening to the rear, the commander a two-part roof hatch opening to the left rear. The gunner has an M411 roof-mounted periscopic sight with magnifications of \times 6 and \times 1, the commander uses the external Ferranti Mk 3 gyroscopic sight by opening his two-part roof hatch. In addition, there are nine periscopes for all-round observation.

Main armament comprises two 20 mm M621 cannon each with 280 rounds of ready-use ammunition. Turret traverse and weapon elevation are hydraulic with manual controls for emergency use. If required, the commander can override the gunner and single shots, bursts or full automatic fire can be selected.

Standard equipment includes radios, intercom and two electrically operated smoke dischargers either side of the turret.

Status: Production as required. Four sold to Gabon on Panhard ERC (6×6) chassis.



SAMM TAB 220 20 mm anti-aircraft turret on Panhard ERC (6 \times 6) chassis in service with Gabon

Manufacturer: Société d'Applications des Machines Motrices, Chemin de la Malmaison, 91570 Bièvres, France.

Telephone: 33 (1) 69 35 80 00 Telex: 933-1 69 41 15 72

Fax: 33 (1) 69 35 81 98

SPECIFICATIONS

ARMAMENT

CREW

AMMUNITION CONTROL traverse elevation 2 (commander and gunner)

 $2 \times 20 \text{ mm cannon}$

560

360° at 80°/s hydraulic -10° to +70° at 50°/s

hydraulic

OPTICS

WEIGHT (with crew and aulic ammunition)

to +70° at 50°/s LENGTH (overall) aulic WIDTH (overall)

M411 sight Ferranti sight AA 7 periscopes

1850 kg 3.69 m

1.81 m

HEIGHT
(above hull top)
DEPTH

(below turret ring)
ELECTRICAL SYSTEM

0.811 m 24 V

0.903 m

Mécanique Creusot-Loire TLi 127 Close Defence Cupola

Development/Description

This TLi 127 close defence cupola has been developed by Mécanique Creusot-Loire for installation on most tracked and wheeled reconnaissance vehicles and armoured personnel carriers.

The cupola is of all-welded steel armour construction and has a fold-down rear-opening door and a fan to extract turret fumes, an interior ceiling light and a searchlight that moves in elevation with the main armament. Armament comprises one 12.7 mm heavy machine gun.

Optional equipment includes dischargers, traverse indicator, an external sight for anti-aircraft role and a 7.62 mm MG as secondary armament.

Status: In production. In service with a number of unspecified countries.

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la Minière, 78034 Versailles Cedex, France.

Telephone: (1) 3097 3737 Fax: (1) 3097 3900



Mécanique Creusot-Loire TLi 127 Close Defence Cupola on Renault VAB APC

SPECIFICATIONS

CREW ARMAMENT **AMMUNITION**

elevation

(ready-use in turret) CONTROL traverse

1 (gunner) 1 × 12.7 mm MG WEIGHT (including guns and ammunition) **OPTICS**

502 kg 4 L794D periscopes M447-02 × 6 magnification periscopic sight

HEIGHT (above vehicle roof) LENGTH OF TURRET (overall) WIDTH OF TURRET

0.955 m

POWER SUPPLY

0.745 m 2.35 m 1.205 m

24 V

100

360° manual -10° to +50° manual

DIAMETER OF APERTURE REQUIRED IN VEHICLE ROOF

0.805 m

Mécanique Creusot-Loire TOI Observation and Intervention Cupola

Development/Description

The TOI (Tourelleau d'Observation et d'Intervention) cupola is designed specifically to be fitted to internal security vehicles such as the RVI VAB VMO (6 × 6) and Peugeot P4 (4 × 4) armoured vehicles.

The basic TOI installation consists of:

(a) a fixed section with cupola bearing and traversable gun racer

(b) a manually rotatable section with armoured windows in an all-welded steel armour shell, a roof hatch with armoured window, a lockable traverse box and a forward facing firing port.

The standard ballistic levels offered are level 3 (for the maintenance of law and order) and 7.62 mm armour-piercing at 100 m range.

The crew member assigned to the cupola has direct visual observation through the armoured windows throughout 360° in traverse and from -40 to +90° in elevation, and can observe the outside events without the need to rotate the cupola.

The cupola firing port may be fitted with a gas tight swivel bearing for an ALSETEX 37 mm, 38 mm or 40 mm grenade launcher or be used for riot guns. The elevation/depression of the grenade launcher varies, -10 to +55° or +10 to +45°, depending upon the calibre and model used.

Externally, either a 7.62 mm light MG mount can be fitted or riot guns be used. If required the customer can specify a DREC Capiro 50 close-in defence system to be fitted.

Optional equipment includes:

- (a) 24 V power supply integrated into the cupola bearing for electrical equipment
- (b) stationary or folding seat
- (c) spotlight and/or TV camera mount with traverse and elevation mechanisms
- TV camera with power zoom
- (e) video recorder system (in vehicle)
- (f) white light or infra-red active spotlight
- (g) monitor installed in cupola
- (h) window protective screen
- windscreen wiper plus windscreen washer with paint dilution agent
- window screening (blackout or sun-shade)
- (k) de-icing, de-misting of armoured glass
- (I) public address loud speaker
- (m)siren
- (n) capability for connection to a remote image retransmission system installed in the vehicle.

Mécanique Creusot-Loire TOI Observation and Intervention Cupola installed on VAB (6 × 6) APC

SPECIFICATIONS

WIDTH

WEIGHT approx 250 kg (depends upon equipment fit required by customer)

TRAVERSE 360° manual HEIGHT 0.505 m top of closed hatch top of open hatch 1.0 m top of spotlight unit 0.830 m

DEPTH (below cupola ring) 0.95 m typical, 1.28 m max

MAX RADIUS with 7.62 mm MG 1.050 m with grenade launcher 0.6 m with spotlight/TV assembly 0.65 m CUPOLA RING 0.834 m max diameter internal diameter 0.805 m

Status: Production as required. In service with at least one undisclosed country (13 RVI VAB VMO/TOI built 1990-91).

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la Minière, 78034 Versailles Cedex, France

Telephone: (1) 3097 3737 Fax: (1) 3097 3900



Mécanique Creusot-Loire CB 127 VE Shield Gun Racer for 12.7 mm Machine Gun

Development/Description

The Mécanique Creusot-Loire CB 127 VE shield gun racer can be fitted to most APCs such as the Panhard M3 (4 x 4) and the Renault VAB. It consists of three components: base, revolving part and the tilting part. The base is attached to the top of the vehicle by 24 bolts and supports the bearing and centring rail. The revolving part consists of a cylindrical ring with three taper roller bearings and four cylindrical centring rollers. A semicircular shield at the front, integral with the ring, supports the weapon cradle trunnions and two semi-circular doors which when open give side protection to the gunner, traverse braking and locking device, weapon and cradle elevation lock, fine laying handwheel, ammunition box support and the box support incorporating the feed tray. The tilting part consists of the weapon support cradle, cartridge case deflector, balance spring for the cradle and the weapon and feeding system integral with the cradle

SPECIFICATIONS

CREW ARMAMENT AMMUNITION CONTROL traverse elevation

1 (gunner) 1 × 12.7 mm MG

360° manual -10° to +65° manual WEIGHT without weapon and ammunition with weapon and ammunition

202 kg 249 kg DIAMETER OF APERTURE REQUIRED IN VEHICLE ROOF HEIGHT ABOVE VEHICLE ROOF

0.44 m

0.705 m

Status: In production. In service with the French Army and many other countries.

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la

Miniére, 78034 Versailles Cedex, France. Telephone: (1) 3097 3737 Fax: (1) 3097 3900



Mécanique Creusot-Loire CB 127 VE shield gun racer for 12.7 mm machine gun on Panhard M3 (4×4) APC

Hispano-Suiza Puma Cupola

Development/Description

This one-man cupola has been designed by Hispano-Suiza for installation on armoured vehicles such as the Vickers Defence Systems Valkyr and the Panhard Buffalo.

It consists of a cupola which is traversed manually by the commander, with a rear-opening, single-piece hatch cover and eight L794 periscopes for all-round observation. As an option the L794 on the forward part of the cupola roof can be replaced by a SOPELEM CN2-508 passive night sight.

Mounted on the forward part of the cupola is a 7.62 mm machine gun with a ready-use box of 200 rounds or a 12.7 mm heavy machine gun with a ready-use box of 150 rounds.

As an option a white light searchlight can be mounted coaxially with the 7.62 mm machine gun which has an electric feed via a slip ring. Another option is remote-control to allow the commander to fire the weapon with the hatch closed.

Status: Production.

Manufacturer: Hispano-Suiza, 333 Bureaux de la Colline, F-92213,

Saint-Cloud Cedex, France.

Telephone: (1) 46 02 70 65 Telex: 203 945



Vickers Defence Systems Valkyr (4×4) APC fitted with Hispano-Suiza Puma cupola armed with 7.62 mm GPMG

Mécanique Creusot-Loire P 127 A Pivot Mount

Development/Description

This pivot mount can be fitted to a variety of combat vehicles and trucks and is also available with a 7.62 mm NF1 or MAG machine gun in place of the standard 12.7 mm M2 HB heavy machine gun.

The pivot mount consists of two parts. The fixed part comprises a tubular stock bearing the pivot. The rotating part consists of the pivot and fork which support the ammunition box support, weapon cradle and cartridge case bag, a device for locking the cradle in any elevation and an elevation/traverse locking device. As an option the P 127 A can be fitted with a rotating seat around the tubular stock.

SPECIFICATIONS

CREW
ARMAMENT
AMMUNITION
CONTROL
traverse
elevation
WEIGHT
without gun or
ammunition
with gun and
100 rounds
ammunition

1 (gunner) 1 × 12.7 mm Browning MG 100

360° manual -15° to +50° (manual)

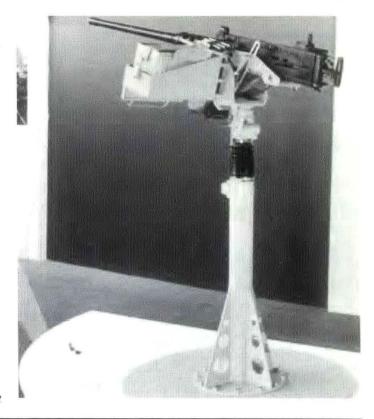
82 ka

125 kg

Status: In production.

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la

Miniére, 78034 Versailles Cedex, France. Telephone: (1) 3097 3737 Fax: (1) 3097 3900



Mécanique Creusot-Loire P 127 A pivot mount

Giat Industries 12.7 mm CIBI 50 turret

Development

This light turret, designed by Giat Industries primarily for the export market, was shown for the first time in 1983. Its only known application so far is on the AMX-10P Marine vehicles supplied to the Indonesian Marines in 1982-83.

Description

The turret is of all-welded steel with a 12.7 mm M2 HB heavy machine gun mounted externally above and an ammunition feed on the left side. The magazine holds 120 rounds of ammunition and a belt stopping device is provided so another belt can be attached before the first is expended. Turret traverse is manual through 360° and weapon elevation is also manual from -10 to +45°. Vision equipment consists of an M6329 periscope sight in the forward part of the turret with magnifications of \times 1 and \times 6 with a single M223 periscope either side. The turret weight with the weapon but without ammunition is 480 kg.

Status: Production as required. In service with the Indonesian Marines.

Manufacturer: Giat Industries, 13 route de la Miniére, 78034 Versailles

Cedex, France

Telephone: (1) 3097 3737 Fax: (1) 3097 3900



Giat Industries 12.7 mm CIBI 50 turret installed on AMX-10P Marine vehicle

Mécanique Creusot-Loire TLi G Series of Machine **Gun Turrets**

Development/Description

The TLi G series of machine oun turrets has been designed for light AFVs such as the Panhard M3 (4 \times 4) APC. The turret is all welded and has a single-piece hatch cover that opens to the rear, fume extractor and a spotlight mounted on the right side of the turret which moves in elevation with the main armament. There are two basic models of the turret: the TLi 52 G armed with a 7.62 NF1 machine gun (left) and a 40 mm smoke discharger (right), and the TLi 80 G armed with a 7.62 mm MAG 80 machine gun (left) and a 40 mm smoke discharger (right).

Variants of the TLi G are the TL 2i 52 armed with twin 7.62 NF1 machine guns and the TL 2i 80 armed with twin 7.62 mm MAG 80 machine guns, all guns having 200/250 rounds of ready-use ammunition. The TL 2i 52 and TL 2i 80 turrets weigh 290 kg complete with sight, weapons and ammunition, and 232 kg without. Elevation, depression and turret traverse are the same as the TLi 52 G and TLi 80 G turrets. Optional equipment includes NBC capability and smoke dischargers.

Status: In production. In service with several undisclosed countries.



Mécanique Creusot-Loire TLi 52 G turret on Panhard M3 (4 × 4) APC

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la Minière, 78034 Versailles Cedex, France

Telephone: (1) 3097 3737 Fax: (1) 30907 3900

SPECIFICATIONS

CREW ARMAMENT 1 (gunner)

1 × 7.62 mm MG 1 × 40 mm

AMMUNITION

discharger 200 ready-use 7.62 mm in turret

CONTROL

traverse elevation 360° manual

-12° to +55° manual

WEIGHT (including sight, weapons and ammunition)

DIAMETER OF APERTURE

REQUIRED IN VEHICLE

OPTICS

ROOF

270 kg 4 periscopes model L794B $M111/3 \times 1$ and $\times 4$

magnification periscopic sight

0.705 m

OVERALL DIAMETER HEIGHT (above vehicle roof)

POWER SUPPLY

24 V

0.48 m

1.008 m

Mécanique Creusot-Loire TLi 52 A Machine Gun Turret

Development

The Mécanique Creusot-Loire TLi 52 A machine gun turret has been designed for installation on most types of APC currently in service, such as the Panhard M3 (4 \times 4) and the Renault VAB (4 \times 4 and 6 \times 6).

Description

It is made of welded steel and has a single-piece hatch cover that opens to the front, an extractor fan and a spotlight mounted to the right of the machine gun which moves in elevation with it. The gunner uses his left hand to traverse the turret and his right for elevating and firing the weapon. The basic TLi 52 A turret is armed with a French 7.62 NF1 machine gun and the TLi 80 A turret with a Belgian 7.62 mm MAG 80 machine gun.

An NBC protected version is available.

Status: In production. In service with several undisclosed countries.

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la

Miniére, 78034 Versailles Cedex, France.

Telephone: (1) 30907 3737 Fax: (1) 3097 3900



Mécanique Creusot-Loire TLi 52 A machine gun turret on roof of Renault VAB

SPECIFICATIONS

CREW ARMAMENT AMMUNITION

CONTROL traverse elevation

360° manual -12° to +45° manual

175 kg

200 ready-use

1 × 7.62 mm MG

1 (gunner)

WEIGHT (including gun and

ammunition)

OPTICS

6 periscopes model L794D 1 × 5 magnification periscopic sight

M602

DIAMETER OF APERTURE REQUIRED IN VEHICLE

ROOF OVERALL DIAMETER HEIGHT (above vehicle roof)

POWER SUPPLY

0.8 m 0.34 m

0.632 m

24 V

SAMM BTM Family of Light Turrets

Development

The BTM family of light turrets has been designed for light AFVs such as the Panhard M3 (4 \times 4) and the Renault VAB (6 \times 6 and 4 \times 4). The BTM 103 has already been adopted by the French Gendarmerie for its Berliet VXB (4 × 4) internal security vehicles.

Description

All turrets are of the all-welded steel type with all-round protection against 7.62 mm rounds fired from any distance and have an adjustable seat for the gunner, single-piece hatch cover that can be locked in three different positions, eight vision blocks, M371 periscopic sight with magnifications of × 1 and × 6 and an extractor fan. The 600 W searchlight has a maximum range of 400 m. The turret weighs between 500 and 600 kg depending on the armament installation and requires an aperture 860 mm in diameter in the roof of the vehicle. Options include a 400 m range coaxial searchlight, a day/night sight with image intensifier (under development), a 60 mm smoke or fragmentation grenade launcher system with two banks of six launchers either side of the turret and a control panel to allow simultaneous firing of six smoke grenades or individual firing of anti-personnel grenades, a 50-300 m range smoke or tear gas grenade launcher coupled to the 7.62 mm MG and capable of firing six rounds in 15 seconds from its six round revolver-type magazine by the pistol grip fire control system, a 40 m range 15-18 bar pressure water/liquid colour agent/CS liquid gun and a loud hailer.

Note: The BTM 208 was previously known as the S365-1 and BTM 103 as the S 365-3.



SAMM BTM 208 turret with coaxial searchlight on Egyptian Fahd (4 × 4) APC

Status: Production (200 built to date - 1 January 1993). In service with a number of countries including France (Gendarmerie) and Kuwait.

Manufacturer: Société d'Applications des Machines Motrices, Chemin de la Malmaison, 91570 Biévres, France.

Telephone: 33 (1) 69 35 80 00 Telex: 933-1 69 41 15 72

Fax: 33 (1) 69 35 81 98

SPECIFICATIONS Model CREW ARMAMENT	BTM 208 1 (gunner) 1 × 12.7 mm MG 1 × 7.62 mm MG	BTM 103 1 (gunner) 1 × 7.62 M 1 × grenade launcher	BTM 105 1 (gunner) 1 × 12.7 mm MG	Anti-Riot 1 (gunner) 1 × grenade launcher 1 × water cannon (range 40 m under 18 bars pressure and can accept specialised riot control liquids)
AMMUNITION	100 × 12.7 mm 200 or 250 × 7.62 mm	200 or 250 × 7.62 mm 24 grenades	100 × 12.7 mm	CS and smoke grenades
ELEVATION/DEPRESSION WEIGHT WITH GUNNER	+45°/-8°	+53°/-10°	+45°/-8°	+45°/-8°
AND AMMUNITION	500 kg	500 kg	500 kg	500 kg

Giat Industries Mascot Remote-controlled 7.62 mm Machine Gun Mount

Development/Description

The Mascot remote-controlled machine gun mount has been designed by Giat Industries to enable the gunner to aim, load and fire a machine gun from within the safety of the vehicle. Installation can either be by a plate whereby the platform needs a 485 mm minimum round or square opening. or by a rotary casting which requires an 830 mm diameter ball bearing track mounting but provides periscopic vision and access for the mount.

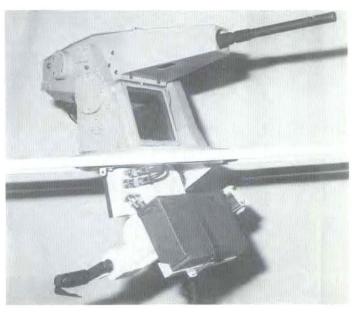
It has already been adopted by Iraq for its Panhard VCR/TH (6 \times 6) anti-tank vehicles fitted with the Euromissile UTM 800 turret with four ready-to-launch HOT ATGWs. In this application the Mascot is installed on the top of the hull at the rear.

The 7.62 mm machine gun has an elevation of +50°, depression of -13° and 360° traverse if there are no obstructions on the roof of the vehicle. A total of 200 rounds of ready-use ammunition is provided and a belt stop system prevents the belt from running out, thus allowing a new belt to be quickly connected. The weapon mount forms a protective housing for the sight system which consists of two mirrors, each with a sight line engraved on it. As an option a telescope with a magnification of × 3 can be fitted to permit more accurate observation and firing. Power supply is through a connecting cord when the mount has limited traverse.

Status: Production as required. The Mascot mount is known to be in service with Iraq.

Manufacturer: Giat Industries, 13 route de la Minière, 78034 Versailles Cedex, France,

Telephone: (1) 3097 3737 Fax: (1) 3097 3900



Giat Industries Mascot remote-controlled machine gun mount showing ammunition box and operator's controls

Mécanique Creusot-Loire CB Shield Gun Racer for 7.62 mm Machine Gun

Development/Description

The CB shield gun racer for a 7.62 mm machine gun has been designed as the main or secondary armament for APCs and equips the French Army VAB (4 × 4) vehicles.

It consists of three main components: base, revolving ring and the tilting part. The base has holes for bolting it to the roof of the vehicle, three taper bearing rollers and the sealing ring for the revolving part. This consists of a circular rail which runs on the three taper rollers welded to a structure which is fitted with the shield hinge pins to the front, two semi-circular folding doors which when vertical provide the gunner with some side protection, opening and locking devices for the doors, traverse braking and locking



Mécanique Creusot-Loire CB shield gun racer with tilting shield for 7.62 mm machine gun

system and the seat strap attachment device. The tilting part consists of a two-position tilting shield, weapon support cradle hinged on the shield, balance spring (cradle and weapon), ammunition box support cradle hinged on the left side of the shield, cartridge case deflector, shield to frame tilt locking device and the cradle to shield locking device.

There are four basic models of the CB: CB 52 with French 7.62 NF1 machine gun; CB 80 with Belgian MAG 80 machine gun; CB 42 with German MG 42 machine gun; and CB 30 with American 7.62 mm (0.30) machine gun. Optional equipment includes a searchlight and a loudspeaker.

SPECIFICATIONS

CREW	1 (gunner)
ARMAMENT	1 × 7.62 mm MG
AMMUNITION	200 ready-use
CONTROL	
traverse	360° manual
elevation manual	-15° to +45° with shield tilted up
	+20° to +80° with shield tilted
	down
WEIGHT	
including ammunition and	
weapon	133 kg
without weapon or	
ammunition	115 kg
DIAMETER OF APERTURE	
REQUIRED IN VEHICLE	
ROOF	varies
HEIGHT OF MOUNT	
(including MG above	
vehicle roof)	0.47 m

Status: In production. In service with French and other armies.

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la Miniére, 78034 Versailles Cedex, France Telephone: (1) 3097 3737 Fax: (1) 3097 3900

Mécanique Creusot-Loire STBE Shield Rotary Mount

Development/Description

The STBE shield rotary mount has been designed for APCs such as the Panhard M3 (4 × 4) and Panhard VCR (4 × 4), or as secondary armament on larger APCs. It is composed of three main components: fixed part, revolving part and the tilting part. The fixed part consists of a circular base which supports the three taper bearing rollers and 22.9 mm diameter attachment holes in the base to allow it to be fitted to the vehicle. The revolving part consists of a circular rail to which the hinged hatch is attached, circular hatch with a central hole for the weapon and the cradle trunnions, ammunition box support incorporated in the forward part of the hatch and an articulated flap in the hatch, hinged on the right, which covers the central hole when the weapon is not fitted, the door and flap locking



Mécanique Creusot-Loire STBE shield rotary installed on Panhard M3 (4 × 4) APC (Christopher F Foss)

mechanism which enables the cradle to be locked in elevation and a traverse locking device. The tilting part consists of the weapon cradle, cartridge case deflector and a balance spring.

There are currently four versions of the STBE: the STBE 52 fitted with a French 7.62 NF1 machine gun; STBE 80 with a Belgian MAG 80 7.62 mm machine gun; STBE MG with German MG 42 machine gun; and the STBE 30 with a 7.62 mm (0.30) Browning machine gun. Optional equipment includes a searchlight.

SPECIFICATIONS

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iditori idiliy
lf open
порел

Status: In production. In service with several undisclosed countries.

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la

Miniére, 78034 Versailles Cedex, France Telephone: (1) 30907 3737 Fax: (1) 3097 3900

Mécanique Creusot-Loire STR Rail-mounted **Rotary Mount**

The Mécanique Creusot-Loire STR (Support Tournant sur Rail) rail-mounted rotary mount is normally mounted on the roof of APCs as their secondary armament. For example, the Panhard M3 (4 × 4) and the Panhard VCR (6 × 6) both usually have an STR rail to the rear of the main armament position.

Description

The STR consists of a half circular rail attached to the roof of the vehicle which supports a trolley that includes four bogie-type rollers. A weapon support cradle is fitted on the upper part of the trolley, and attached to this is an ammunition box support on the left side. A trolley locking device on the lower turntable trolley is used to facilitate installation of the weapon and to prevent the trolley from moving when the weapon is removed. The gunner shoulders the weapon normally and, using the handle on the trolley, moves it in elevation and traverse.

The following versions of the STR are currently available: STR 52 with French 7.62 NF1 machine gun and STR 80 with Belgian MAG 80 machine



Panhard M3 (4 × 4) APC with Mécanique Creusot-Loire STR rail-mounted rotary mount at rear and Mécanique Creusot-Loire STBE shield rotary mount at front

Status: In production. In service with several countries.

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la Miniére, 78034 Versailles Cedex, France.

Telephone: (1) 3097 3737 Fax: (1) 3097 3900

SPECIFICATIONS

ARMAMENT AMMUNITION CONTROL traverse

elevation

1 (gunner) 1 × 7.62 mm MG 200 ready-use

90° left and right manual -15° to +45° manual

WEIGHT

ammunition including AA 52 MG and 200 rounds of ammunition DIAMETER OF APERTURE REQUIRED IN VEHICLE ROOF

excluding weapon and

0.7 m

28 kg

45 ka

HEIGHT OF MOUNT (including ammunition box) above roof of the vehicle

0.54 m

Mécanique Creusot-Loire STR TA All-Round Railmounted Rotary Mount

Development/Description

The STR TA (Support Tournant sur Rail Tout Azimuth) consists of a circular rail fitted with attachment legs, trolley fitted with four bogie-type rollers, weapon bracket integral with the trolley, an ammunition box support and a handle. The STR TA is fitted with a 7.62 mm machine gun, with 200 rounds of ready-use ammunition, which has a traverse of 360° and can be elevated from -10 to +40°. Weight of the support is 33 kg and weight with 7.62 NF1 machine gun and 200 rounds of ammunition is 50 kg. A lock device allows locking the trolley with or without the weapon attached to the rail. The weapon can easily be re-installed within seconds.

In operation the gunner shoulders the weapon and, using the handle, moves it in traverse and elevation.

Status: Production. In service with the French Army.

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la Miniére, 78034 Versailles Cedex, France

Telephone: (1) 3097 3737 Fax: (1) 3097 3900



Mécanique Creusot-Loire STR TA all-round rail-mounted rotary mount fitted with 7.5 mm machine gun

Mécanique Creusot-Loire STB V Shield Rotary Mount

Development/Description

The STB V (Support Tournant Bouclier) consists of three main components: a fixed part, a swivelling part and an oscillating part. The fixed part has 20×9 mm diameter holes for attaching it to the roof of the vehicle and three taper rollers. The swivelling part is mounted on the fixed part and consists of an armoured door which forms a shield when open, retractable support for the ammunition box, flap hinged to the door, an azimuth braking device, a door and a flap locking device which also enables the cradle to be locked in elevation. The oscillating part consists of the weapon cradle which is linked to the door and a spring for balancing the door and the weapon mount unit.

The mount can be traversed through 360° and elevation ranges from -15° to +80° depending on the aperture of the door. Weight of the complete mount with 7.62 mm machine gun and 200 rounds of ready-use ammunition is 120 kg and 100 kg without weapon and ammunition.

Status: Production. In service with the French Army and several other undisclosed countries.

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la Miniére, 78034 Versailles Cedex, France.

Telephone: (1) 3097 3737 Fax: (1) 3097 3900



Mécanique Creusot-Loire STB V shield rotary mount with hatch fully raised installed on VAB (6 × 6) APC

Mécanique Creusot-Loire CP 127 A Pivot Gun Racer

Development/Description

The CP 127 A (Circulaire Pivot) consists of a circular baseplate, bolted to the roof of the vehicle by 18 bolts, and the ball bearings. Mounted on this is the rotating part which carries the traversing gearbox, pivot support for the weapon, back rest and a cloth strap that forms the seat. Mounted on the front part there is a swivelling fork which carries the oscillating weapon cradle fitted with the empty cartridge case bag, an ammunition box support and a locking device to lock the cradle at any elevation angle. The CP 127 A is fitted with a 12.7 mm (0.50) M2 HB heavy machine gun which can be laid through 360° with the traversing gear box. Using the handles, the weapon can be traversed through ±30° and elevated from -15° to +50°. Weight of the CP 127 A without the machine gun is 95 kg and with it and 100 rounds of ready-use ammunition is 160 kg.

Status: Production. In service with the French Army.

Manufacturer: Giat Industries/Mécanique Creusot-Loire, 13 route de la

Miniére, 78034 Versailles Cedex, France

Telephone: (1) 3097 3737 Fax: (1) 3097 3900



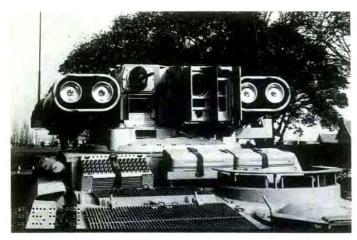
Mécanique Creusot-Loire CP 127 A pivot gun race fitted with 12.7 mm M2 HB machine gun

Giat Industries Lancelot HOT Turret

Development/Description

The Lancelot turret has been designed for APCs such as the AMX-10P, RVI VAB and the M113. The two-man turret has four Euromissile HOT ATGWs ready-to-launch with two on either side of the turret. The missiles in their launcher tubes can be elevated +18° and depressed -12°. The commander has an M427 rangefinding telescope with a magnification of × 8 while the gunner has an M509 monocular telescope, for launching the missiles, with two magnifications (× 3 and × 12). Both crew members have

an adjustable seat and a hatch cover in the roof of the turret. The gunner has electric and manual controls and the commander has manual controls only. The turret also has six periscopes and two vision blocks for all-round observation. Mounted on the top of the turret are four electrically operated smoke dischargers. Once the four missiles have been launched the turret is manually loaded from inside the vehicle. In the case of the AMX-10P another 14 missiles are carried in the hull.



Giat Industries Lancelot HOT turret on AMX-10P vehicle

Status: Production as required. In service with Saudi Arabia and other undisclosed countries.

SPECIFICATIONS

CREW ARMAMENT

CONTROL

traverse

elevation

OPTICS

gunner

turret

commander

no crew)

WEIGHT (with 4 missiles,

DIAMETER OF TURRET

4 ready-to-launch HOT ATGWs

360° electric at 17°/s (manual at 10°/s) -12° to +18° electric at

30°/s (manual at

26°/s)

laser rangefinder with × 8 magnification sight with \times 3

and × 12 magnification 6 periscopes 2 vision blocks

1300 kg

1.33 m

RING Manufacturer: Giat Industries, 13 route de la Minière, 78034 Versailles

Cedex, France

Telephone: (1) 3097 3737 Fax: (1) 3097 3900

GERMANY

KUKA One-man Turret E23

Development/Description

This turret has been developed by KUKA as a private venture. It is of modular design and, by mounting the corresponding assemblies, all requirements for main and secondary armament, day and night sights and power drive can be met.

The turret is made of aluminium armour plate, capable of withstanding small arms fire and shell fragments. An enclosed cradle accommodates the gun and is mounted on the hollow support above the cupola. This design provides ballistic protection for the gunner, ammunition, feeding system and weapon and prevents the penetration of fumes and CO2 gases into the crew compartment. Further advantages are increased space for the gunner, large depression of the weapon even in a slope position of the vehicle and good access to the weapon for maintenance

The armament consists of a 30 mm automatic cannon Mauser MK 30F, but the turret can accept a number of other weapons such as the 25 mm Oerlikon-Contraves gun series. Additionally, a 7.62 mm machine gun can be mounted coaxially with the cannon.

Traverse and elevation laying of the weapons is effected via an electrical laying system with manual backup. Loading, cocking, firing, reloading and unloading of the weapon are remote-controlled under armour protection. The weapons are fed via rigid and flexible chutes through the hollow turret support. Two types of ammunition (HE and AP) can be selected and fired on the central panel. The gun is fired electrically by the switch in the elevation gear handle or, in the event of an electrical power failure, there is a manual foot firing system.

Under-armour observation and sighting is accomplished by six vision blocks and one PERI-Z16 periscope, combined with a sighting telescope (\times 2 and \times 6 magnifications), providing 360° vision. For accurate firing, the KUKA patented mechanical ballistic drive is provided. This device includes selection marks for HE and AP ammunition as well as a graded range scale up to 2000 m.

Optional equipment includes: turret stabilisation system; passive night sight; thermal imager; smoke grenade launchers; radio and intercom.

KUKA one-man turret E23 armed with 30 mm Mauser MK 30F cannon and pod of four manportable surface-to-air missiles

SPECIFICATIONS

CREW ARMAMENT main secondary on option **AMMUNITION** 30 mm

7.62 mm CONTROL (electrical) traverse elevation

1 (gunner)

1 × 30 mm automatic cannon

1 x 7.62 mm MG

140 ready-use HE 170 ready-use AP 500 ready-use rounds

360°; 0.2 mil/s min; 75°/s max -8° to +50° at 0.2 mil/s min; 40°/s max

OPTICS

WEIGHT (including gun and ammunition) POWER SUPPLY

Status: Ready for production.

periscopic sight type PERI-Z16, × 2 and × 6 magnification, six vision blocks

2000 kg 24 V

Manufacturer: KUKA Wehrtechnik GmbH, Zugspitzstrasse 140, PO Box 43 13 69, D-8900 Augsburg 43, Federal Republic of Germany Telephone: (821) 797-0 Telex: 5383 840 Fax: (821) 797 1207

KUKA Two-man Marder 1 Turret

This two-man turret was designed, developed and manufactured by KUKA for the Marder 1 IFV. It has been introduced into the German armed forces with more than 2100 units.

Description

The Marder 1 turret is armed with a top-mounted 20 mm automatic cannon Rheinmetall MK 20 Rh 202 and a coaxial 7.62 mm machine gun MG 3. It can also accept a number of other weapons such as the 25 mm Mauser E or 25 mm Oerlikon-Contraves KBA.

The main advantages of the top mounting principle are: small turret dimensions; full protection against fumes and carbon monoxide gases; large depression range of the weapon even in a slope position of the vehicle; and good access to the weapon for maintenance.

This turret is an all-welded steel construction, capable of withstanding 20 mm rounds at the front. The commander sits on the left and the gunner on the right, each with one adjustable seat and a single-piece hatch cover. Turret traverse and gun elevation are operated electrohydraulically. Loading, cocking, firing, reloading and unloading of the weapon is remote-controlled under armour protection. The weapons are fed via rigid and flexible chutes through the hollow turret support. Two types of ammunition (HE and AP) can be selected and fired on the central panel. A dual-control system allows both the commander and the gunner to operate the turret and fire the weapons, thereby allowing the commander to override the gunner's system. In case of a failure of the hydraulics or the electrics, the turret can be manually operated by mechanical gear boxes and the weapon can be fired by foot controls.

Under-armour observation and sighting are accomplished by eight periscopes for the commander and three periscopes for the gunner, as well as two combined sighting and observation periscopes type PERI-Z11. In the latest turret configuration (Marder 1A3) there is one type PERI-Z11 combined sighting and observation periscope and one thermal imager. For accurate firing, the KUKA-patented mechanical ballistic drive is provided. This device includes selection marks for HE, AP and MG ammunition, as well as a graded range scale up to 2000 m.

Optional equipment includes: passive night sight; thermal imager; smoke grenade launchers; radio and intercom and support for MILAN ATGW.

Variants

CREW

coaxial **AMMUNITION**

20 mm

25 mm

7.62 mm

The latest configuration of the Marder 1 turret is the Marder 1A3 version which is an upgraded variant of the KUKA two-man Marder 1 turret for the conversion programme of the 2100 Marder 1A1(-)/Marder 1A1(+)/Marder 1A1A/Marder 1A2 to the Marder 1A3 ICV standard.

2 (commander

1 × 7.62 mm MG

345 ready-use HE

75 ready-use AP

55 ready-use AP

255 ready-use HE

500 ready-use rounds



Upgraded Marder 1A3 fitted with upgraded KUKA two-man upgraded turret

After a short development period the upgrading programme for the Marder 1A3 vehicle started in 1988 with the first modernised vehicle being handed over to the German Army at KUKA's facilities in Augsburg in 1989. The project will be completed over a 10 year period at the rate of 210 vehicles per year.

The upgrading programme comprises the following elements:

- (1) improvement of the ballistic protection by addition of a 1600 kg add-on armour package which includes conformal add-on armour elements to both sides of the turret
- (2) increased overall vehicle performance
- (3) improvement in human crew engineering aspects
- (4) improvement of several operational functions
- (5) the installation of a thermal imager in the turret optics system.

Status: Production of upgraded version for Marder 1A3 started in 1989. In service with German Army.

Manufacturer: KUKA Wehrtechnik GmbH, Zugspitzstrasse 140, PO Box 43 13 69, D-8900 Augsburg 43, Federal Republic of Germany. Telephone: (821) 797-0 Telex: 5383 840 Fax: (821) 797 1207

ARMAMENT	
main	

SPECIFICATIONS

and gunner) 1 × 20/25 mm automatic cannon CONTROL traverse

elevation

OPTICS

gunner

commander

electrohydraulic 360°, min 0.3 mil/s, max 45°/s at 3°/turn of handle electrohydraulic

-17° to +65°, min 00.3 mil/s max 40°/s at 2°/turn of handle

PERI-Z11 sight (x 2 and × 6 magnification) eight vision blocks periscopes PERI-Z11 sight. three vision blocks

WEIGHT (including guns and ammunition)

20 mm 2300 kg 2560 kg 25 mm POWER SUPPLY 24 V

KUKA Two-man Low-profile Turret E4A1

Development/Description

The E4A1 armoured turret has been developed by KUKA for use as the main armament of reconnaissance vehicles, APCs and IFVs. It is designed primarily to engage ground targets but also has a self-defence capability against aerial targets.

The two-man turret is ballistically protected against 14.5 mm rounds over its frontal arc and can be armed with either a 25 mm or 30 mm automatic cannon and, optionally, a 7.62 mm MG - the type and make of which is at the discretion of the customer.

On the prototype a 25 mm Mauser E automatic cannon and a 7.62 mm MG3A1 machine gun have been fitted to the weapon support structure which is adjustable in height.

The support area is hermetically sealed so as to prevent entry of noxious firing gases into the crew compartment. Traverse and elevation laying of the weapons is effected by an electrical laying system with manual backup for emergency purposes.

The ammunition for both weapons is stored in boxes inside the turret from where it is fed to the guns. Empty cases and links are ejected from the turret through an opening which can be closed when the vehicle is not in combat.



KUKA two-man E4A1 low-profile turret

316 AFV TURRETS AND CUPOLAS / Germany

The crew can use either weapon, select the type of ammunition (HE or AP for the automatic cannon) or the firing mode (single round, burst or sustained fire) according to the tactical situation. The commander can override the gunner and fire both weapons himself. The firing is done electrically with a manual backup unit in case of system failure.

For sighting and observation two combined PERI-Z16 periscopes are fitted - one for the commander and one for the gunner - with 11 observation periscopes. As an option the gunner's PERI-Z16 periscope can be replaced by a night vision image intensify telescope. The commander's sight may also be replaced in the same manner. A thermal imager sight may also be used to replace the PERI-Z16.

Other options available for the turret include: turret stabilisation system, smoke grenade launchers and intercom network.

SPECIFICATIONS

CREW 2 (commander and gunner) ARMAMENT 1 x 25 mm or 30 mm automatic cannon

AMMUNITION 225 ready-use HE 185 ready-use AP

CONTROL (electrical)

traverse elevation 360° at 60°/s max

-10° to +50° at 40°/s max

OPTICS

commander one combined PERI-Z16 observation and sighting

periscope (\times 2 and \times 6 magnification) 8 periscopes

one combined PERI-Z16 aunner

observation and sighting periscope (x 2 and x 6 magnification) 3 periscopes

WEIGHT (including

weapons and ammunition) 2622 kg POWER SUPPLY 24 V

Status: Ready for production.

Manufacturer: KUKA Wehrtechnik GmbH, Zugspitzstrasse 140, PO Box 43 13 69, D-8900 Augsburg 43, Federal Republic of Germany.

Telephone: (821) 797-0 Telex: 5383 840 Fax: (821) 797 1207

KUKA Gun Mount E6-IIA1

Development/Description

This weapon station was originally developed by KUKA for the airportable Wiesel vehicle. It is also being offered for other vehicles which need an extremely lightweight mount with high fire power.

The armament consists of an electrically fired 20 mm automatic cannon Rheinmetall MK 20 Rh 202 or a 25 mm Mauser MK 25E (qv next entry) provided with 160 ready-use rounds. Traverse and gun elevation are operated manually by mechanical gears.

The gunner aims the cannon through a combined observation and sighting periscope PERI-Z16 which has a magnification of × 6 for engaging ground targets and a × 2 magnification for aerial targets. An image intensifying night sight telescope can easily be installed in the sight frame.

SPECIFICATIONS

CREW 1 (gunner) ARMAMENT 1 × 20 mm cannon AMMUNITION 160 ready-use CONTROL

50° left and right, manual traverse elevation -10° to +60° manual a combined observation and OPTICS sighting periscope type PERI-Z16

magnification x 2 and x 6 WEIGHT (including cannon

and ammunition) 404 ka

Status: Production. In service with the German Army (on Wiesel airportable vehicle)

KUKA gun mount E6-IIA1 with 20 mm cannon showing two ammunition

Manufacturer: KUKA Wehrtechnik GmbH, Zugspitzstrasse 140, PO Box 43 13 69, D-8900 Augsburg 43, Federal Republic of Germany Telephone: (821) 797-0 Telex: 5383 840 Fax: (821) 797 1207



KUKA Gun Mount E6-II-25

Development/Description

This weapon station was developed by KUKA for installation on light armoured vehicles such as the airportable Wiesel vehicle and can engage both ground and aerial targets.

The armament consists of an electrically fired 25 mm Mauser MK 25E automatic cannon with a dual feed ammunition arrangement to allow optional firing of two ammunition types. A total of 100 HE and 60 AP readyuse rounds are provided. Traverse and gun elevation are operated manually by mechanical gears with a station locking device and brake.

The gunner aims the cannon through a combined PERI-Z16 sighting and observation periscope which has magnifications of \times 2 and \times 6. The range scale is up to 2000 m. The sight can be easily replaced by an active or passive night vision sight assembly

SPECIFICATIONS CREW

ARMAMENT AMMUNITION

CONTROL traverse elevation

OPTICS

WEIGHT (including cannon and ammunition)

1 (gunner) 1 × 25 mm cannon 160 ready-use rounds (100

HE + 60 AP)

360° at 2.73°/turn of handle -10° to +45° at 4°/turn of handle combined observation and

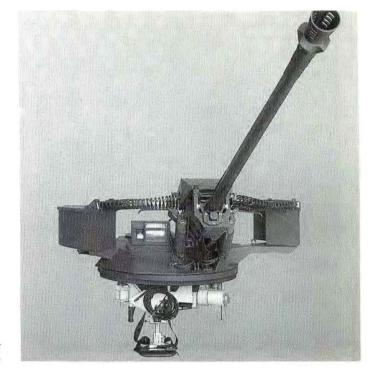
sighting periscope type

PFRI-716 with magnifications of \times 2 and \times 6

496 kg

Status: Pre-production.

Manufacturer: KUKA Wehrtechnik GmbH, Zugspitzstrasse 140, PO Box 43 13 69, D-8900 Augsburg 43, Federal Republic of Germany. Telephone: (821) 797-0, Telex: 5383 840 Fax: (821) 797 1207



KUKA gun mount E6-II-25 complete with the Mauser 25 MK 25E automatic cannon

Rheinmetall TS-7 20 mm Turret

Development

The TS-7 20 mm two-man turret was developed as the primary armament system of the Spähpanzer Luchs (8×8) reconnaissance vehicle, 408 of which were delivered to the German Army by Thyssen Henschel between 1975 and 1978. The turret can, however, be installed on a wide range of vehicles

Description

The TS-7 turret has spaced armour for improved protection, with the commander seated on the left and the gunner on the right, both with a single-piece hatch cover that opens to the rear. Both the commander and gunner are provided with a PERI-Z11 A-1 periscope for aiming the 20 mm cannon and there are 12 periscopes for all-round observation.

On the gunner's side of the turret is the WBG (thermal imaging and night surveillance and sighting system) with an extension for the vehicle commander.

Turret traverse and weapon elevation/depression are electrohydraulic and can be operated by the commander or gunner. An azimuth system is fitted as standard.

The main armament is a dual-feed 20 mm Rheinmetall MK 20 Rh 202 cannon which is separated from the crew of two by a gas- and explosion-proof compartment. Empty cartridge cases are ejected to the right of the turret.

A 7.62 mm MG3 machine gun mounted on a skate mount over the commander's hatch can be used for anti-aircraft defence. Four electrically operated smoke dischargers are mounted either side of the turret.

Status: Production as required. In service with the German Army.



Rheinmetall two-man turret TS-7 with automatic cannon MK 20 Rh 202 for 8 × 8 reconnaissance vehicle Luchs used by German Army

Manufacturer: Rheinmetall GmbH, Ulmenstrasse 125, PO Box 6609, D-4000 Düsseldorf 30, Federal Republic of Germany.

Telephone: (211) 447 483290 Telex: 85833-0

SPECIFICATIONS

CREW

ARMAMENT main anti-aircraft

2 (commander and gunner)

1 × 20 mm cannon 1 × 7.62 mm MG AMMUNITION

main

anti-aircraft SMOKE DISCHARGERS 375 (300 HE and 75 AP)

100

4 either side or

turret

CONTROL

traverse elevation

OPTICS main

secondary

WEIGHT (with ammunition)

360° electrohydraulic

-15° to +69° electrohydraulic

2 periscopic sights 12 periscopes 2155 kg

Rheinmetall 20 mm TS-15 Turret Family

Development/Description

The Rheinmetall TS-15 one-man turret family has been designed for use on wheeled and tracked light armoured vehicles of the German Federal Armed Forces. They can also be fitted to such vehicles as the Thyssen Henschel 4×4 Condor APC and the Greek Leonidas tracked APC.

There are two versions, the TS-15 GP general-purpose variant for engaging ground targets and the TS-15 EOD special turret variant for Explosive Ordnance Reconnaissance and Disposal (EOR/EOD). The latter is due for installation on the EOD Fuchs vehicle for use at German Air Force bases, Navy installations and Army depots.

The turrets are equipped with an internally mounted 20 mm Rheinmetall MK 20 Rh 202 automatic cannon fitted with a single belt ammunition feeder and a coaxial 7.62 mm MG3 machine gun. Six 76 mm multi-purpose grenade launchers are mounted in banks of three either side of the turret for system and crew close-in protection.

To preclude powder smoke inhalation and reduce blast noise, the weapon and crew compartments are separated from each other by air-tight bulkheads. The turrets are positively pressurised by the vehicle ventilation system for NBC protection.

All turret and weapon maintenance as well as servicing operations and ammunition reloading can be accomplished under armour by the gunner.

318 AFV TURRETS AND CUPOLAS / Germany

For its special EOD task of destroying mines and GP bombs from as close as 30 m up to 250 m, the TS-15 EOD turret is equipped with a special \times 6 magnification target designation and integrated laser rangefinder (for automatic parallax correction) sight. The vehicle commander designates the target to be fired on through his target designation equipped binoculars and vectors the gunner by means of direction signals displayed in the gunner's sight.

The TS-15 GP turret is equipped with a standard gunner's sight and has no laser rangefinder or target designation equipment.



Rheinmetall 20 mm TS-15 turret armed with 20 mm cannon and 7.62 mm machine gun

SPECIFICATIONS

CREW

ARMAMENT $\begin{array}{ll} \text{main} & 1\times 20 \text{ mm MK 20 Rh 202 cannon} \\ \text{coaxial} & 1\times 7.62 \text{ mm MG3 MG} \\ \text{grenade launchers} & 2\times 3.76 \text{ mm} \end{array}$

AMMUNITION
20 mm 220
7.62 mm 500
CONTROL

depression/elevation -7° to +60° manual traverse 360° manual OPTICS

TS-15 EOD × 6 magnification periscope with laser rangefinder and target

designation capability

1 × periscope and 5 × vision block

TS-15 GP × 4 magnification periscope

1 × periscope and 5 × vision block
OUTER TURRET DIAMETER 1.18 m
VEHICLE OPENING DIAMETER 1.125 m

WEIGHT
without ammunition 875 kg
with ammunition 962 kg

Status: TS-15 GP - ready for production. TS-15 EOD - in final development phase.

Manufacturer: Rheinmetall GmbH, Ulmenstrasse 125, PO Box 6609, D-4000 Dusseldorf 30, Federal Republic of Germany.

Telephone: (211) 447 483290 Telex: 85833-0

Rheinmetall 20 mm Turret TF 20 15.A

Development

This turret has been designed as a private venture by Rheinmetall and is similar to the TF 20 15 described in the following entry but has increased armour protection and a coaxial 7.62 mm machine gun. The weapons can be used to engage both air and ground targets.

Description

The one-man turret is made of all-welded steel and has a single-piece hatch cover that opens to the rear. The main armament is a single Rheinmetall 20 mm MK 20 Rh 202 cannon which is separated from the gunner by a gas-tight bulkhead. The cannon is cocked hydraulically and fired mechanically with auxiliary hydromechanical firing. The gunner can select either single shots or full automatic fire.

Mounted to the right of the 20 mm cannon is a coaxial 7.62 mm machine gun which is cocked mechanically and fired electrically.

The gunner aims the cannon and 7.62 mm machine gun via a roof-mounted periscope with a magnification of \times 4 and 15° field-of-view, and which has a monocular eyepiece and a filter. In addition, the turret has one observation periscope, five vision blocks and two rear-view mirrors.

Mounted either side of the turret are three electrically operated Wegmann multi-purpose smoke/grenade dischargers.

Electrical equipment includes: main and weapon control box; communications control box; internal lighting with dimmer; white light searchlight mounted coaxially with the main armament; slip ring for transmission of electrical power and communications; and firing of vehicle grenade launchers with fire zone limiter.

Status: Development complete. Ready for production.



Rheinmetall one-man 20 mm turret TF 20 15.A with coaxial 7.62 mm machine gun

Manufacturer: Rheinmetall GmbH, Ulmenstrasse 125, PO Box 6609, D-4000 Düsseldorf 30, Federal Republic of Germany.

Telephone: (211) 447 483290 Telex: 85833-0

SPECIFICATIONS CREW ARMAMENT	1 (gunner)	CONTROL traverse elevation	360° manual -7° to +60° manual	WEIGHT without ammunition with ammunition	878 kg 965 kg
main	1 × 20 mm cannon	OPTICS		DIAMETER	
coaxial	1 × 7.62 mm MG	main	× 4 magnification	outer	1.18 m
AMMUNITION			periscope	vehicle opening	1.125 m
main	220	supplementary	1 periscope, 5 vision	-	
coaxial	500		blocks		

Rheinmetall 20 mm Turret TF 20 15

Development

This turret has been designed by Rheinmetall as a private venture for light armoured vehicles such as the Thyssen Henschel Condor APC and is a simplified version of the TF 20 15.A with less armour protection and no coaxial machine gun. Its high elevation enables it to be used as an anti-aircraft weapon in addition to its primary ground-to-ground role.

Description

The one-man turret is made of all-welded steel and has a single-piece hatch cover that opens to the rear. Main armament comprises a single Rheinmetall 20 mm MK 20 Rh 202 cannon which is separated from the gunner by a gas-tight bulkhead. The cannon is fired hydromechanically and the gunner can select either single shots or full automatic fire. The gunner aims the cannon via a roof-mounted periscope with a magnification of \times 4 and a single eyepiece, a selectable grey filter and an illuminated graticule. The turret also has two roof-mounted periscopes and four vision blocks for observation to the sides and rear.

Optional equipment includes: a blue flashing light; coaxial 7.62 mm machine gun; interior lighting; loudspeaker system; night vision equipment; searchlight and smoke dischargers.

SPECIFICATIONS

CREW 1 (gunner) ARMAMENT 1 × 20 mm cannon **AMMUNITION**

OPTICS

main × 4 magnification

periscope

2 periscopes and 4 supplementary

vision blocks

CONTROL

360° manual at 9.3°/s traverse elevation -7° to +60° manual

at 6.5°/s

WEIGHT

without ammunition 535 kg with ammunition 612 kg DIAMETER (at base) 1.18 m

HEIGHT

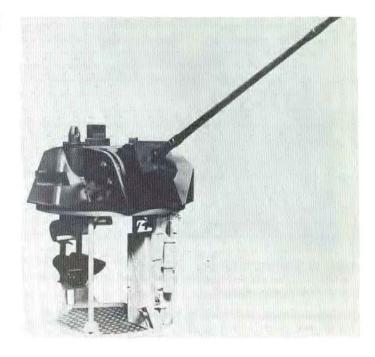
(above vehicle hull

including periscope) 0.685 m

Status: Production. In service with undisclosed countries.

Manufacturer: Rheinmetall GmbH, Ulmenstrasse 125, PO Box 6609,

D-4000 Düsseldorf 30, Federal Republic of Germany. Telephone: (211) 447 483290 Telex: 85833-0



Rheinmetall one-man 20 mm turret TF 20 15

KUKA Type 605 12.7 mm Turret

Development

This one-man turret has been designed as a private venture by KUKA and by late 1983 two prototypes had been completed and had undergone successful trials with a NATO army.

Description

The turret is of all-welded construction and provides the gunner with complete protection from small arms fire and shell splinters. The 12.7 mm M2 HB heavy machine gun, with a cyclic rate of fire of 550 rds/min, is mounted on the left with the gunner on the right. The gunner has a singlepiece hatch cover which opens to the rear, a PERI-Z11 or PERI-Z16 combined sight and observation periscope with a magnification of × 2 and × 6, and seven periscopes.

The weapon and ammunition are separated from the gunner's compartment and servicing hatches can be taken off with the aid of quickrelease catches. All tasks such as loading, reloading, cocking and firing the machine gun can be carried out inside the turret under complete armour protection. The complete 12.7 mm M2 HB machine gun, including the barrel, can be moved back into the turret.

Two firing modes are available: electrical push button integrated into the laying handle and mechanical backup via pedal. The gunner can select burst or sustained fire.

The 12.7 mm M2 HB machine oun can be elevated from -15 to +65° and has a turret traverse of a full 360°. Turret traverse and weapon elevation are manual.

The following optional equipment can be fitted: electrohydraulic or electrical gun laying system; active or passive night sight; interior lighting; searchlight/ spotlight; intercom; and external smoke dischargers.



KUKA Type 605 one-man low-profile turret with 12.7 mm M2 HB machine gun fitted on Thyssen Henschel Condor (4 × 4) armoured personnel carrier

Status: Ready for production.

Manufacturer: KUKA Wehrtechnik GmbH, Zugspitzstrasse 140, PO Box 34 13 69, D-8900 Augsburg 43, Federal Republic of Germany. Telephone: (821) 797-0 Telex: 5383 840 Fax: (821) 797 1207

SPECIFICATIONS CREW ARMAMENT	1 (gunner) 1 × 12.7 mm MG	CONTROL (manual) traverse	360° at 2°/turn of handle	DIAMETER OF TURRET HEIGHT	0.67 m
AMMUNITION	300 ready-use	elevation	-15° to +65° at	above vehicle roof	0.38 m
OPTICS			3.5°/turn of handle	inc periscopes	0.513 m
main	PERI-Z11 or Z16 sight	WEIGHT		DEPTH BELOW VEHICLE	
	with magnification	turret	665 kg	ROOF	1.116 m
	of \times 2 and \times 6,	weapon	39 kg	POWER SUPPLY	24 V
supplementary	7 periscopes	ammunition SWEPT RADIUS	46 kg		
		(including MG)	1.4 m		

Rheinmetall Twin 7.62 mm Machine Gun Turret TUR-1

Development

This turret has been designed as a private venture by Rheinmetall for light AFVs such as the Thyssen UR-416 APC.

Description

The one-man turret is all-welded and has a single-piece hatch cover that opens to the rear. Main armament consists of twin Rheinmetall 7.62 mm MG3 machine guns, each with 250 rounds of ready-use ammunition and 250 rounds carried in reserve in the turret. Firing is electromechanical and the gunner can select left or right machine guns or both together, and burst or full automatic fire. If required the machine guns can be quickly removed and used as infantry weapons.

The gunner aims the weapons via a roof-mounted PERI-Z12 tilting mirror periscope with a $17^{\circ} \times 5^{\circ}$ field-of-view. The gunner also has five vision blocks, one in the turret rear and two either side of the turret, and one roof-mounted periscope.

Optional equipment includes: a blue flashing light; interior lighting; loudspeaker; searchlight and smoke dischargers.

Status: Production as required.

Manufacturer: Rheinmetall GmbH, Ulmenstrasse 125, PO Box 6609,

D-4000 Düsseldorf 30, Federal Republic of Germany. Telephone: (211) 447 483290 Telex: 85833-0

Rheinmetall one-man twin 7.62 mm machine gun turret TUR-1



SPECIFICATIONS

CREW ARMAMENT

AMMUNITION (per gun)

OPTICS main

supplementary

2 × 7.62 mm MG3 MGs

250 ready-use 250 in reserve

1 (gunner)

periscopic with ballistic graticule 1 periscope and 5

CONTROL MG3 traverse

elevation

WEIGHT without ammunition with ammunition 360° manual at 10.7°/s HEIGHT

max -8° to +55° manual at 5.7°/s max

350 kg 378 kg 1.19 m

EXTERNAL DIAMETER HEIGHT (above hull top including periscope) POWER SUPPLY

0.53 m 24 V DC via sli

24 V DC via slip ring from vehicle power supply

Wegmann/Heckler Gun Mount Type 2365

vision blocks

Development/Description

The internally operated gun mount Type 2365 for light automatic weapons has been designed both as a main armament system for lightly armoured vehicles such as APCs and as a secondary armament for heavier vehicles for use against surface and aerial targets.

It can be mounted on top of any vehicle type capable of taking a circular track mounting and be adapted to take the majority of available machine gun, automatic rifle or sub-machine gun models. If required it can also be fitted as a stationary mount for the protection of fixed installations.

The gun mount is protected against 7.62 mm AP ammunition, incendiary devices and NBC conditions and is fitted with a Type BZP 2300 periscopic

Close up of TM 170 fitted with gun mount Type 2365 and showing ammunition feed on left side of mount

sight with an integrated ranging facility and automatic gravity drop correction setting system. Firing by the operator is electrical with the mode being of the sustained type. A hatch provides access to the weapon, which in the case of a machine gun is fed from a standard belt, with up to 250 rounds, in a box attached outside the vehicle.

Optional equipment includes a periscopic gun sight with night vision capability and the night vision assembly.

SPECIFICATIONS

HEIGHT

above vehicle installed	0.505 m
trunnion height above top of vehicle	0.405 m
MAX INSTALLATION	
DEPTH BELOW TOP OF	
VEHICLE	0.40 m
MAX INSTALLATION	
DEPTH BELOW TOP OF	
VEHICLE WITH CONTROLS	
FOLDED AWAY	0.28 m
MAX TRAVERSE	
RADIUS WITH GUN	
(G8/FN MG) MOUNTED	0.98/1.18 m
MAX TRAVERSE	
RADIUS INSIDE VEHICLE	0.53 m
CONTROL	
elevation/depression	-10°/+60°
traverse	360°
WEIGHT	
(less weapon and depending on fit)	about 140 kg

Status: In production. In service with unspecified countries.

Manufacturers: Wegmann and Co GmbH, August-Bode Strasse 1, PO Box 103967, D-3500 Kassel, Federal Republic of Germany. Telephone: (561) 105-0 Telex: 99 859 Fax: (561) 105 2208

Heckler & Koch GmbH, D-7238 Oberndorf/Neckar, Federal Republic of Germany.

Telephone: 07423 79-1 Telex: 760 313 HUKO D Fax: 07423 79406

Wegmann/Heckler Machine Gun Mount Type MZA 1865

Development/Description

The remote-controlled gun mount Type MZA 1865 has been designed both as a main armament system for lightly armoured vehicles such as APCs, police or security vehicles and as a secondary armament system for heavier vehicles such as MBTs for use against ground and aerial targets.

It can be mounted on top of any vehicle type capable of accepting a circular track mounting and be adapted to take the majority of available machine gun, automatic rifle or sub-machine gun models. If required, it can also be fitted as a stationary mount for the protection of fixed installations. For special operations the upper section of the mount can also be rapidly mounted or dismounted complete with the weapon. After fitting it again there is no need to readjust the upper mount.

The powered gun mount is protected against 7.62 mm AP ammunition. incendiary devices and NBC conditions and is fitted with a periscopic Type LZP 2050 1.5 to 7.5 magnification zoom lens with integrated ranging facility and automatic gravity drop correction setting system. A wiper/washer system is provided for the sight.

The operator can select either single shot, limited burst or sustained firing modes with an empty ammunition container being signified by the operation of an automatic firing inhibitor system. The ammunition is fed out from inside the vehicle in belts of up to 250 rounds in the case of a machine gun, although a hatch is provided for access to other weapon types such as the 12.7 mm (0.5 in) machine gun.

A protective shroud can be fitted over the weapon and three extra vision blocks can be provided to give a 160° field-of-view in the direction of fire. If required, a coaxial searchlight can also be fitted.

Optional equipment is a reversible day/night sight assembly.

CRECIEICATIONS

SPECIFICATIONS	
HEIGHT	
above vehicle (installed)	0.505 m
trunnion height	
above top of vehicle	0.405 m
MAX INSTALLATION	
DEPTH BELOW TOP OF	
VEHICLE	0.4 m
MAX INSTALLATION	
DEPTH BELOW TOP OF	
VEHICLE WITH CONTROLS	
FOLDED AWAY	0.28 m
MAX TRAVERSE WITH	
GUN (G8 MG) MOUNTED	0.98 m



TM 170 fitted with machine gun mount Type MZA 1865 with spotlight mounted coaxial to the left of the weapon

MAX TRAVERSE

on fit)

RADIUS INSIDE	
VEHICLE	0.53 m
CONTROL	
elevation/depression	+60°/-10°
traverse	360°
WEIGHT	
(less weapon and depending	

Status: In production (300 systems produced to date - 1 January 1993). In service with unspecified countries.

about 160 kg

Manufacturers: Wegmann and Co GmbH, August-Bode Strasse 1, PO Box 103967, D-3500 Kassel, Federal Republic of Germany. Telephone: (561) 105-0 Telex: 99 859 Fax: (561) 105 2208

Heckler and Koch GmbH, D-7238 Oberndorf/Neckar, Federal Republic of Germany

Telephone: 07423 79-1 Telex: 760 313 HUKO D Fax: 07423 79406

Wegmann Type 2706 Machine Gun Mount

Development/Description

The Type 2706 12.7 mm (0.50 in) machine gun mount is a further development of the Type MZA 1865 machine gun mount (qv) variant adapted with a larger diameter ring so that the ammunition supply can be belt-fed from the inside of the vehicle.

At the same time the number of general observation vision blocks has been increased to six so as to provide all-round viewing.

This system is modular, therefore other weapon types such as the 7.62 mm FN MAG, MG3 or HK81 can be substituted for the 12.7 mm machine gun. The other options available include:

(a) weapon drives electric azimuth and elevation

azimuth drive with 1:50 transmission

azimuth with two switchable laying speeds

(1:10 and 1:500)

(b) sighting system unity magnification sight mirror

— × 1.5 to × 7.5 magnification zoom sight

× 1.5 or × 7.5 magnification switchable sight

zoom and switchable sight with variable rangefinder capability

fixed magnification sight (various types)

night sight capability

SPECIFICATIONS

HEIGHT	
trunnion from race ring	0.6 m
MOUNTING DEPTH FROM	
RACE RING	0.461 m
OUTER DIAMETER GUN	
MOUNT BASE PLATE	1.112 m
ACCESS HATCH	
DIAMETER	0.5 m
MAX TRAVERSE	
RADIUS WITH 12.7 mm MG	1.85 m
CONTROL	
traverse	360° man

manual mechanical -10° to +50° manual mechanical elevation



Wegmann Type 2706 12.7 mm (0.50 in) machine gun mount installed on TM 170 (4 × 4) APC and showing ammunition feed to left of weapon

OPTICS	6 × vision blocks
	1 × weapon sight
COMBAT WEIGHT	
(with 12.7 mm MG)	350 kg
POWER SUPPLY	24 V DC

Status: Production. In service with several undisclosed countries.

Manufacturer: Wegmann and Co GmbH, August-Bode Strasse 1, PO Box 103967, D-3500 Kassel, Federal Republic of Germany Telephone: (561) 105-0, Telex: 99 859 Fax: (561) 105 2208

INTERNATIONAL

Euromissile HOT UTM 800 Turret

Development/Description

This turret has been designed as a private venture by Euromissile for AFVs in the 5000 to 12 000 kg class, such as the M113, ENGESA EE-11 Urutu (6 × 6), RVI VAB (4 × 4 and 6 × 6) and Panhard VCR (6 × 6) APCs. For trials purposes it has also been installed on a MOWAG Piranha (8 x 8) vehicle.

The one-man UTM 800 turret has four HOT ATGWs ready to launch and, in the case of the Panhard VCR (6 × 6), 10 missiles carried in reserve. Once the missiles have been launched new missiles are loaded manually without the crew leaving the vehicle. Turret elevation and traverse are electric with manual control available for emergency use.

A description of the HOT ATGW is given in the Vehicle-mounted ATGW section of this book.

A CASTOR infra-red thermal imager sight fitted to the launcher allows day and night observation and firing out to the 4000 m range of the HOT

In 1992 an improved turret system was tested successfully on the Austrian Pandur armoured vehicle. This uses a bispectral tracking system (operating at 1µm and 10µm wavelengths) to give high resistance to IR iammers.

SPECIFICATIONS

CREW ARMAMENT SIGHTING

1 (gunner) 4 HOT ATGWS APX M509 with × 12 magnification (5° field-of-view) and × 3 (18° field-of-view), night/day thermal imaging CASTOR sight

CONTROL traverse

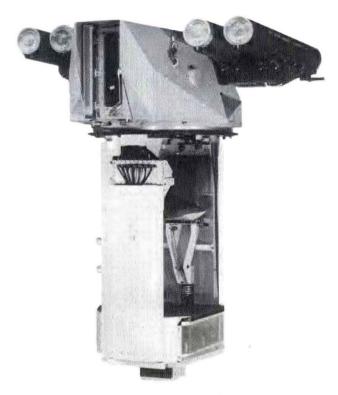
360° electric at 30°/s max

-10° to +22° electric elevation

at 5°/s max WEIGHT (with 4 missiles) 900 kg

POWER SUPPLY 27 V DC, rotary base iunction box

Status: Production (150 produced to date - 1 January 1993). In service with Iraq (108 on VCR chassis), Qatar (24 on VAB chassis) and Cyprus (18 on VAB chassis). The exact status of the Iraqi systems is uncertain



Euromissile HOT UTM 800 turret with four HOT ATGWs ready to launch

Manufacturer: Euromissile GIE, 12 rue de la Redoute, F-92260 Fontenayaux-Roses, France

Telephone: (33) 1 46 61 73 11 Telex: EUROM 204 691F Fax: 46 61 64 67

Euromissile HOT Mephisto System

The HOT Mephisto system has been designed by Euromissile to meet the requirements of the French Army where it is mounted on the VAB (4 × 4) APC, but it can be fitted to many other types of APC such as the Panhard VCR (4 × 4). More recently it has been installed for trials on a MOWAG Piranha (8 × 8) APC.

Description

The Mephisto system consists of a launcher and four ready-to-launch missiles. When travelling it is retracted into the vehicle so that the top of the launcher is almost flush with the roof making identification of a vehicle fitted with the Mephisto system very difficult.

When elevated the launcher can be traversed through 360°. The optical assembly comprises a periscope, the rotating head of which is fitted with a gyrostabilised mirror which enables the gunner to observe and fire regardless of the movement of the vehicle. When the launcher is retracted the periscope can be used for forward observation. The reloading equipment comprises two revolving magazines at the rear of the vehicle, each containing four HOT ATGWs. When the launcher is retracted after the four missiles have been launched it is reloaded from the revolving magazines.

A description of the HOT ATGW is given in the Vehicle-mounted ATGW section of this book.

An infra-red thermal imager sight is fitted on the periscopic sight so allowing day and night observation and firing through the full range of the HOT missile.

The French Army has introduced the following improvements to its Mephisto systems:

- (a) Night Sight MEPHIRA
- (b) Anti-jamming localiser operating at 1µm wavelength.



Euromissile HOT Mephisto system on French Army VAB with launcher raised

Status: In production (135 plus produced to date - 1 January 1993), In service with French Army on VAB (4×4) chassis.

Manufacturer: Euromissile GIE, 12 rue de la Redoute, F-92260 Fontenayaux-Roses, France,

Telephone: (33) 1 46 61 73 11 Telex: EUROM 204 691F Fax: 46 61 64 67

field-of-view) and × 3

(18° field-of-view)

plus 8 HOT ATGWs

Euromissile MILAN Compact Turret (MCT)

Development

This lightweight turret has been designed as a private venture by Euromissile for light tracked and wheeled vehicles such as the BDX (4 \times 4) APC (crew of nine plus eight MILAN ATGWs), Panhard M3 (4 × 4) APC, Alvis Spartan APC, Fox reconnaissance vehicle and the Transportpanzer 1 (6 × 6) APC.

The MILAN MCT can be mounted on any vehicle with a hatch diameter of 600 mm or more and carries two MILAN ATGWs ready to launch. The system allows the missiles to be launched by the gunner from inside the



vehicle. Operation and guidance of the weapon remain unchanged due to the use of the original assembly groups from the basic infantry MILAN system. The missiles can also be launched at night with the MILAN night sight fitted

A description of the MILAN ATGW is given in the Vehicle-mounted ATGW section of this book

Following trials with two Euromissile MILAN MCT on Alvis Spartan APCs, this system was accepted for service with the British Army on 18 June 1985. A total of 67 systems were deployed by British mechanised infantry battalions from 1986. Each Spartan has two MILANs ready to fire and another 11 inside for manual reloading, with seven on the left side and four on the right.

SPECIFICATIONS

electric at 5°/s max

1.45 m

2.7 m

1.6 m

CREW 1 (gunner) ARMAMENT 2 MILAN ATGWs SIGHTING periscope with × 7 magnification

CONTROL 360° manual traverse -15 to +15° manual elevation WEIGHT

without MILAN ATGWs approx 170 kg with MILAN ATGWs and

MIRA night sight approx 200 kg

Status: Production as required (71 produced to date - 1 January 1993). In service with the British Army (on Spartan)

Manufacturer: Euromissile GIE, 12 rue de la Redoute, F-92260

Fontenay-aux-Roses, France.

Telephone: (33) 1 46 61 73 11 Telex: EUROM 204 691F Fax: 46 61 64 67

Euromissile MCT turret

ISRAEL

RAFAEL Overhead Weapon Station

Development

The RAFAEL Overhead Weapon Station (OWS) can be installed on a variety of APC and IFV vehicle types or be installed as a fortified static

Three OWS add a weight of 480 kg to an M113 and still allow it to function as a personnel carrier whilst permitting protected gun laying and firing. All that is required to fit the installation is a 430 mm diameter clearance hole, fastening holes and a connection to the vehicle's electrical supply.

Description

Two modes of operation are possible; remote and manual. For remote usage the gunner operates the post with a 7.62 mm M240 machine gun fitted whilst fully protected under armour. The firing is actuated electrically, with a mechanical backup. Aiming is done through a periscope sight which is part of the station. This has a \times 1 magnification wide 25° field-of-view window including a collimated aiming circle and parallel \times 8 magnification day sight narrow 8° field-of-view with ballistic reticule range-scale, a × 1

magnification window wide 22° field-of-view with collimated aiming circle and parallel × 7 magnification narrow 7.2° field-of-view 25 mm image intensifier passive night vision elbow with either a ballistic reticle rangescale or laser aiming spot.

The day and night sights allow recognition of a human target at 1200 m. The sights are easily and rapidly interchanged by means of four quick locking latches. No boresighting is required after replacement

In the manual mode the gunner stands behind the post and fires the gun himself. Aiming is done through the weapon's own sights.

For stability the weapon station is constantly locked in position by a brake unless the operator holds and presses the handles. Quick orientation can be performed by using an azimuth indicator on the station showing how its position is relative to the vehicle's centre line.

Alternative weapons can be installed including the 12.7 mm Browning heavy machine gun. It can also be adapted for the 40 mm Mk 19 automatic grenade launcher. An infra-red searchlight can be mounted to the left of the gun on a small mast platform unit.



SPECIFICATIONS

CREW 1 DIMENSIONS height overall 1 100 m 0.570 m height over deck BEARING DIAMETER 0.430 m TRAVERSE RANGE ±180° **ELEVATION** -25° to +75°

ARMAMENT 1 x 7.62 mm M240 machine gun AMMUNITION 230-round external magazine or 230/460-round internal magazine

COMBAT WEIGHT 160 kg

Status: Production. In service with the Israeli Army and offered for export.

Manufacturer: RAFAEL, PO Box 2250/80, IL-31021 Haifa, Israel.

Telephone: (972) 4 794784 Telex: 471508 VERED IL

Fax: (972) 4 794703

RAFAEL Overhead Weapon Station armed with a 7.62 mm machine gun

Menachem Urman Centurion Tank Commander's Cupola

Development/Description

This cupola was designed by Menachem Urman and Company Limited to meet the requirements of the Israeli Army for a cupola which would give the tank commander unobstructed 360° vision while retaining full head protection.



This is achieved by incorporating a slit position in addition to the usual three hatch cover positions (closed, open and vertical) which gives the tank commander a 360° view through the 70 mm slit while the deep hatch cover provides overhead protection. The periscopes have two positions, extended and retracted, and dust covers are provided to seal the periscope openings. A 7.62 mm machine gun can be mounted externally on the cupola.

SPECIFICATIONS

CREW 1 (commander) ARMAMENT 1 x 7.62 mm MG DIMENSIONS $1.1 \times 1.04 \times 0.3 \text{ m}$ TRAVERSE 360° manual **BODY ARMOUR**

THICKNESS 80 mm (min) WEIGHT 530 kg

Status: Production as required. In service with the Israeli Army. The cupola is currently being evaluated by several other countries. A cupola for the T-55 and T-62 MBTs of former Soviet origin is being developed.

Manufacturer: Menachem Urman and Company Limited, POB 56, Yahud. Israel.

Centurion tank commander's cupola with hatch cover vertical

Urdan Industries Low-Profile Commander's Cupola

Development/Description

This cupola was designed by Urdan Associated Steel Foundries Company Limited, now Urdan Industries Limited, to meet the requirements of the Israeli Army. It is used to reduce the silhouette of the M48/M60 tank series from its original height. The cupola can be traversed manually through 360° and has three periscopes with two positions, extended and retracted. Dust covers seal the periscope openings when they are retracted. In addition to the usual three cover positions (closed, vertical and full open), the hatch can be opened in a slit position giving the tank commander 360° vision with the deep hatch cover providing overhead protection. A 7.62 mm machine gun can be pintle-mounted externally on the forward part of the cupola.

In January 1976 the United States Army placed an order with Associated

Steel Foundries Company Limited for 600 cupolas for American M48A5 tanks, a contract worth \$3.5 million. The first 50 cupolas were delivered from Israel in mid-1976 and final deliveries of the original order were in 1977. Since then many hundreds have been produced for the Israeli Army and foreign customers.

SPECIFICATIONS

CREW 1 (commander)

ARMAMENT typically 1 x 7.62 mm MG but cupola can be adapted to

customer's requirements

TRAVERSE 360° manual 340 kg

WEIGHT MAX CUPOLA

DIAMETER 0.905 m HEIGHT (from hull roof) 0.24 m

Status: In production (2350 produced to date - 1 January 1993). In service with the Israeli Army, Taiwanese Army (on M48H), US Army and other unspecified countries.

Manufacturer: Urdan Industries Limited, Industrial Zone, IL-42378 Natanya,

Israel.

Telephone: 972-53-338074 Telex: 341822 UASF-IL

Fax: 972-53-610246



Low-profile tank commander's cupola with hatch shut

Urdan Industries Commander's Cupola for M88A1 ARV

Development/Description

The M88A1 commander's low-profile cupola was developed by Urdan Industries Ltd to meet the requirements of the Israeli Defence Forces and is similar in concept to that company's low-profile Commander's Cupola for M48/M60 series MBT (qv).

SPECIFICATIONS

CREW 1 (commander)

ARMAMENT typically $1 \times 12.7 \text{ mm MG}$

TRAVERSE 360°
WEIGHT 270 kg
MAX CUPOLA DIAMETER 0.88 m
HEIGHT (from hull roof) 0.3 m

Status: Production as required. In service with the Israeli Army.

Manufacturer: Urdan Industries Ltd, Industrial Zone, IL-42378 Natanya,

Israel.

Telephone: (972) 53 338074 Telex: 341822 UASF-IL

Fax: (972) 53 610246



Urdan Industries commander's cupola for M88A1 ARV

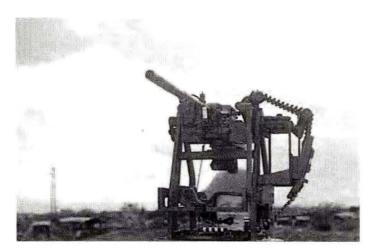
AMCORAM Ltd WP-7 Under Armour Overhead Weapon Post

Development/Description

The WP-7 is an advanced under armour, overhead weapon post suitable for a variety of applications, including installation on a number of armoured fighting vehicle types. The WP-7 allows the gun, an FN 7.62 mm MAG (US Model M240), to be fully operated from under armour. All operations target acquisition, loading, cocking, aiming and firing are carried out under the full protection of the platform's hull armour. Aiming in all modes of operation is done through one sight in day or night conditions.

The two basic modes of operation are:

- (a) Remote
 - with completely closed hatch the gunner carries out all operations under armour



AMCORAM WP-7 Under Armour Overhead Weapon Post

- (ii) with opened hatch and folded periscope, allowing a completely open view and the best tactical command situations, Fighting In Built Up Area (FIBUA) and anti-aircraft engagements
- (iii) with open hatch and opened periscope
- (b) Manual with the gunner behind the station and firing the weapon in the normal manner.

The WP-7 can also be adapted for use with the 7.62 mm M60, FN 5.56 mm Minimi (US Model M249) and other machine gun types. The unit has separate locking for traverse and elevation, and is fitted with a last round indicator. Optional equipment fits include a thermal imager, set beam (search light) and laser aiming device.

SPECIFICATIONS

DIMENSIONS	
required installation bore	402 mm
height over deck	500 mm
height below deck	400 mm
width	400 mm
length	600 mm
WEIGHT	95 kg
ELEVATION LIMITS	-20 to +60°
TRAVERSE	360°
ARMAMENT	see text
AMMUNITION	

outside 230 round belt in ammunition box inside 320 rounds belted

SIGHT Falcon sight (red point type)
NIGHT VISION DEVICE OEC P/N 21205

COCKING METHOD Manual, by wire, from outside and

inside FIRING METHOD manual with cable

Status: Production (FN 7.62 mm MAG (US Model M240) version).

Manufacturer: AMCORAM Ltd. 10 Hapeled Street, Industrial Zone, Holon

58811, Israel.

Telephone: (972) 3-805533 Fax: (972) 3-805536

RAMTA Improved TOW/MAPATS Vehicle

Development/Description

The RAMTA Improved TOW/MAPATS Vehicle is essentially an M113 series APC fitted with a retractable launcher for the US TOW, MILAN or Israeli MAPATS anti-tank missiles. The system can, however, be installed on a wide range of other tracked and wheeled armoured fighting vehicles. It has been developed to meet the requirements of the Israeli Defence Forces. The system requires no additional power requirements and is run off the vehicle's existing 24 V electrical system.



RAMTA Improved TOW/MAPATS Vehicle with launcher raised into firing position

Mounted in the rear of the M113 is a retractable telescoping post which. when not required for use, folds down into the rear troop compartment. The standard roof hatch then folds forwards to provide complete overhead armour protection. The post can be raised hydraulically with manual controls provided for emergency use. A platform for the gunner (left) and commander (right) raises with the post. The gunner is provided with all of the controls necessary for raising and lowering the post as well as controlling the missile. The vehicle has a four-man crew consisting of vehicle commander, gunner, charger and driver. The M113 retains its 7.62 mm and 12.7 mm machine guns for local protection.

When installed on the M113A1 vehicle a total of 10 missiles is carried inside the vehicle, but when installed on the M113A2 a total of 19 missiles is carried. This is because the internal fuel tank on the M113A2 has been relocated from its position on the left side of the vehicle hull to two external fuel tanks mounted on either side of the rear ramp. The reserve missiles are stowed horizontally on the right side of the hull with quick release hatches. The vehicle also carries the normal infantry tripod kit so enabling the TOW, MILAN or MAPATS launcher to be dismounted for use if required by the tactical situation.

SPECIFICATIONS

WEAPON COVERAGE IN AZIMUTH	180°
MAX HEIGHT ABOVE VEHICLE DECK	1.265 m
NUMBER OF MISSILES CARRIED (M113A1)	10
NUMBER OF MISSILES CARRIED (M113A2)	19
TIME TO RAISE LAUNCHER	60 s
TIME TO LOWER LAUNCHER	45 s
ELECTRICAL SYSTEM	24 V

Status: In production. In service with the Israeli Army

Manufacturer: RAMTA Structures and Systems Ltd, PO Box 323, Beer Sheva, Israel.

Telephone: 972 (57) 72231 Telex: 5298

Fax: 972 (57) 38083

ITALY

OTO Melara T 90 CKL Turret

Development

This two-man turret has been developed as a private venture by OTO Melara for installation on both tracked and wheeled vehicles. By late 1983 two prototypes of this turret had been completed and installed on the Type 6616 (4 × 4) armoured car and OTO Melara C13 tracked APC for trials.

The turret is of all-welded steel construction and provides complete protection from 7.62 mm small arms fire from any angle; some parts of the turret front provide complete protection from 7.62 mm AP attack.

The commander sits on the left and the gunner on the right, both with a single-piece hatch cover opening to the rear. The gunner has an Alenia P204 periscopic sight with a magnification of × 8 and a 9° field-of-view while the commander has five periscopes for all-round observation.

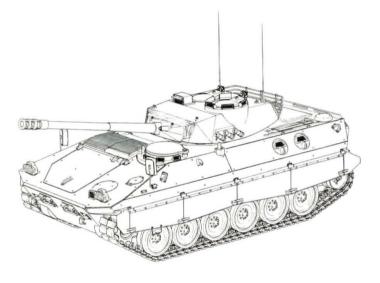
Main armament consists of a Cockerill 90 mm Mk III gun with a 7.62 mm machine gun mounted coaxially with the main armament. Three electrically operated smoke dischargers are mounted either side of the turret.

Turret traverse and weapon elevation are electric, with manual controls for emergency use. The commander can also traverse the turret.

The turret traverse bearing is made of high tensile steel with wire races and chromium plated steel balls. Seals provide protection against water and dust. The turret basket consists of a light alloy platform, on which both the commander's and gunner's seats (adjustable for height) are installed, and ammunition stowage for the main armament. The radios, which can be operated by the commander/loader or gunner, are mounted in the turret

Optional equipment includes: a night sight; laser rangefinder; laser fire control system; white light searchlight; and a 7.62 mm anti-aircraft machine gun on the roof with elevation from -15 to +65°.

200



OTO Melara C13 APC fitted with OTO T 90 CKL turret

Status: Development complete. Ready for production.

Manufacturer: OTO Melara, via Valdilocchi 15, I-19100 La Spezia, Italy. Telephone: (0187) 530 111 Telex: 270 368 OTO I Fax: (0187) 530 669

SPECIFICATIONS

coaxial

WEIGHT (loaded) CREW 2 (commander and CONTROL 1750 kg LENGTH (overall) 360° at 30°/s, electric 4.66 m gunner) traverse ARMAMENT WIDTH -9° to +30° at 10°/s elevation 1.78 m HEIGHT main 1 × 90 mm gun electric 0.77 m above hull top coaxial 1 × 7.62 mm MG OPTICS below hull top SMOKE DISCHARGERS 2 × 3 77 mm commander 5 periscopes 0.917 m POWER SUPPLY **AMMUNITION** aunner 1 × P204 periscopic 24 V 12 sight main

OTO Melara T 60/70 A Turret

Development

This turret has been designed as a private venture by OTO Melara for installation on tracked and wheeled armoured fighting vehicles.

Description

The two-man, power-operated turret is of all-welded aluminium armour construction. The commander sits on the left and the gunner on the right, both with a rear-opening single-piece hatch cover and adjustable seats. The basic aluminium armour provides protection against 7.62 mm armour-piercing projectiles but, if required, additional armour can be added.

Main armament comprises an OTO Melara 60 mm high velocity gun system fully described in the *AFV Armament* section. A 7.62 mm machine gun is mounted coaxially with the 60 mm weapon and mounted on either side of the turret is a bank of four forward-firing electrically operated smoke dischargers.

Turret traverse is electric through a full 360° and the main and secondary armament can be elevated from –6 to +50°. Manual controls are provided for emergency use.

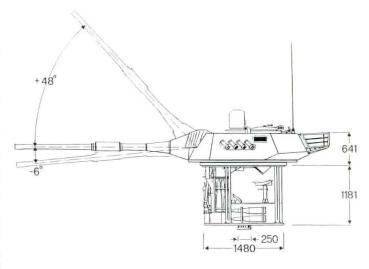
The 60 mm high velocity gun system is fitted with a twin automatic loading system that enables it to load and fire either APFSDS-T or HE ammunition at any elevation with a rate of fire of one round every two seconds.

The loading system consists of a twin symmetrical magazine, loading arm, round loading system and a loading control system. The magazine contains a total of 32 rounds, 16 of which are ready to fire.

The loading arm receives the selected round, APFSDS-T or HE, from either magazine and automatically carries it in line with the gun barrel, where a spring-actuated rammer seats it in the cartridge chamber.

This loading system is hydraulically operated through a built-in hydraulic power unit mounted in the turret basket and is controlled by an electric control system with a minimum number of electrical interlocks.

The radios are mounted in the turret bustle and an intercom system is fitted as standard.



OTO Melara T 60/70 A turret

Variant

There is also a manual version of this turret called the T 60/70 M armed with the same weapon. In 1987 this version was installed for trials purposes on the FIAT/OTO Melara Type 6616 (4×4) armoured car.

Status: Prototype.

Manufacturer: OTO Melara, via Valdilocchi 15, I-19100 La Spezia, Italy. Telephone: (0187) 530 111 Telex: 270 368 OTO I

1.181 m

1.48 m

24 V

Fax: (0187) 530 669

SPECIFICATIONS

CONTROL **DEPTH OF TURRET** CREW 2 (commander and gunner) traverse 360° electric **BELOW RING** TURRET RING DIAMETER ARMAMENT elevation -6° to +48° electric 1×60 mm gun WEIGHT LOADED 4000 kg POWER SUPPLY main coaxial 1 × 7.62 mm MG LENGTH OF TURRET 6.165 m SMOKE DISCHARGERS WIDTH OF TURRET 2.1 m **AMMUNITION** HEIGHT OF TURRET

main 8 + 8 ready to fire plus ABOVE RING 0.641 m (excluding periscopes)

coaxial 700 ready rounds

OTO Melara/BREDA T 25 Turret

Development This two-man, p

This two-man, power-operated turret, designed as a private venture by OTO Melara and Breda, is a further development of the two-man turret armed with a 20 mm cannon installed on the FIAT-OTO Melara Type 6616 (4×4) armoured car.

Description

The turret is of all-welded steel construction with the gunner seated on the right and the commander on the left, both crew members having a single-piece hatch cover opening to the rear and a height adjustable seat.

Turret traverse and weapon elevation are electric with manual controls for emergency use. Main armament comprises a 25 mm Oerlikon-Contraves KBA dual-feed cannon with a 7.62 mm MG3 coaxial machine gun. Mounted either side of the turret, towards the rear, is a bank of three electrically operated smoke dischargers.

The gunner has a roof-mounted periscopic sight type P204 with a magnification of \times 8 and a 9° field-of-view, while the commander has nine P137 periscopes for all-round observation. The radios, installed in the turret bustle, can be operated by either crew member.

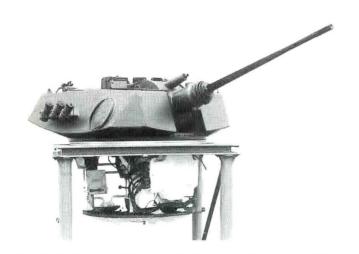
Other types of sights and fire control systems can be installed on customer request.

HEIGHT

SPECIFICATIONS

2 (commander and electric 360°, 40°/s above hull roof. CREW traverse 0.57 m gunner) max excluding periscopes electric, -10° to ARMAMENT elevation below turret roof 0.917 m $1 \times 25 \text{ mm KBA}$ POWER SUPPLY main +50°, 25°/s 24 V OPTICS cannon coaxial 1 × 7.62 mm MG3 MG commander 9 periscopes SMOKE DISCHARGERS 2 × 3 77 mm 1 periscopic sight gunner AMMUNITION WEIGHT (without 25 mm, ready-use 135 HE + 35 APDS 1600 kg crew) 7.62 mm, ready-use 400 LENGTH (overall) 3.768 m smoke grenades, ready-use WIDTH 1.78 m

CONTROL



Status: In production. In service with Spain (M242 Bushmaster) and Denmark (25KBA).

Manufacturers: OTO Melara, via Valdilocchi 15, I-19100 La Spezia, Italy. Telephone: (0187) 530 111 Telex: 270 368 OTO I Fax: (0187) 530 669

Breda Meccanica Bresciana SpA, Via Lunga, 2, I-25125 Brescia, Italy.
Telephone: (030) 37911 Telex; 300 056 BREDAR I Fax: (030) 322115

(Also made under licence in Spain by SANTA BARBARA.)

OTO Melara/BREDA T 25 two-man turret showing basket

Breda 25 mm Low-Profile T25 Turret

Development/Description

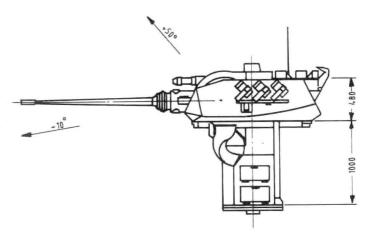
The one-man T25 is made from welded high strength ballistic steel plate and is capable of providing protection against small arms fire and shell splinters from small calibre rounds fired at 100 m horizontally. Typical installations include light tracked and wheeled armoured vehicles such as the M113 APC.

The turret carries a twin feed 25 mm Oerlikon-Contraves KBA cannon as its main armament. The gunner has a periscope sight providing a wide or narrow field-of-view. An optional image intensifier night vision module can be fitted. To the right of the gunner's position is his control panel. The traverse, elevation and cannon firing operations are all electrically powered.

traverse, elevation and cannon firing operations are all electrically powered. Secondary armament is a coaxial 7.62 mm machine gun whilst six multipurpose grenade launchers are fitted in banks of three either side of the turret.

SPECIFICATIONS

0. 2011 1011110110	
CREW	1
ARMAMENT	
main	1 × 25 mm KBA cannor
coaxial	1 × 7.62 mm MG3 MG
grenade launchers	2 × 3
AMMUNITION (ready use)	
25 mm	200
7.62 mm	500
grenades	6
CONTROL	
elevation/depression	-10° to +50°, electrical
max angular speed	40°/s
min angular velocity	0.5 mil/s
traverse	360°, electrical
max angular velocity	50°/s
min angular velocity	0.5 mil/s



Side elevation drawing of Breda 25 mm Low Profile T25 two-man turret (not to 1/76th scale)

OPTICS	see text
WEIGHT	
empty	980 kg
combat (without crew)	1120 kg
POWER SUPPLY	24 V DC

Status: Final development phase.

Manufacturer: Breda Meccanica Bresciana SpA, Via Lunga, 2, I-25125

Brescasia, Italy.

Telephone: (030) 379111 Telex: 300 056 BREDA I Fax: (030) 322115

OTO Melara SIDAM 25 Anti-aircraft Turret

Development/Description

This one-man hydraulically powered SIDAM turret was developed by OTO Melara to meet an Italian Army requirement for an anti-aircraft gun system. It is in production for mounting on M113A2 standard APCs although it can be mounted on other AFVs such as the Spanish ENASA BMR 3560, Brazilian Engesa EE-11 Urutu (6 \times 6) APC, OTO Melara C13 APC and the VCC 80 IFV.

The turret system includes an Officine Galileo MADIS optronic primary sight with a self-stabilised optical dual periscope assembly that has daylight TV, low-light level TV, laser rangefinder and IFF subsystems.

The fire control system computer is installed in the vehicle body with the gunner's console and an attitude inertial sensor.

Direct target detection and acquisition can be performed by the commander in the turret by visual or optical sight means. Target designation can be accepted via data link from external sources.

The armament comprises four Oerlikon 25 mm KBA automatic cannons, two of which have dual feed mechanisms for HE and APDS ammunition selection. Maximum rate of fire is 600 rds/min per gun with a total of 640 HEI-T and 30 APDS-T ready-use rounds carried in the turret magazines. This is sufficient for eight two-second bursts of full automatic fire based on the practical turret rate of fire of 2400 rds/min.



OTO Melara SIDAM 25 turret installed on a modified M113 series APC of the Italian Army

Elevation is from -5° to $+87^{\circ}$. Turret width is approximately 1800 mm, turret height from hull ring to the top of its roof is 1187 mm and turret depth from hull ring to bottom of the projecting internal hull unit is 1150 mm. The diameter of the projecting internal hull unit is 1480 mm.

Turret weight in the combat ready condition is 3200 kg with another 660 kg of ancillary units and the APU in the main vehicle hull.

Status: Production. In service with the Italian Army (on modified M113A2 standard APCs).

Manufacturer: OTO Melara, via Valdilocchi 15, I-19100 La Spezia, Italy. Telephone: (0187) 530 111 Telex: 270 368 OTO I

Fax: (0187) 530 669

OTO Melara TC 20 Turret

Development

This two-man, power-operated turret, designed by OTO Melara as a private venture, has been installed on all production FIAT-OTO Melara Type 6616 (4×4) armoured cars built so far.

Description

The turret is of all-welded steel construction with the commander on the left and the gunner on the right, both with an adjustable seat and a single-piece hatch cover that opens to the rear. Turret traverse and weapon elevation are electric with manual controls for emergency use.

Main armament comprises a Rheinmetall MK 20 Rh 202 20 mm cannon with a coaxial 7.62 mm MG3 machine gun. Mounted either side of the turret, towards the rear, is a bank of three electrically operated smoke dischargers.

The commander has nine Alenia P137 periscopes for all-round observation, and the gunner has a P204 roof-mounted periscope with a magnification of \times 1 for general observation and \times 8 for aiming purposes. The P204 can be replaced by a P194 image intensification night sight with a magnification of \times 8.

The radios are mounted in the turret bustle and can be used by both crew members.

Status: In production. In service with the Italian Army and other countries.



OTO Melara OTO TC 20 turret

Manufacturer: OTO Melara, via Valdilocchi 15, I-19100 La Spezia, Italy. Telephone: (0187) 530 111 Telex: 270 368 OTO I

Fax: (0187) 530 669

SPECIFICATIONS					
CREW	2 (commander and	CONTROL		LENGTH (overall)	3.539 m
	gunner)	traverse	electric, 360°, 40°/s	WIDTH	1.78 m
ARMAMENT			max	HEIGHT	
main	1 × 20 mm cannon	elevation	electric, -5° to +35°,	above hull, inc	
coaxial	1 × 7.62 mm MG3 MG		25°/s max	periscopes	0.694 m
SMOKE DISCHARGERS	2 × 3	OPTICS		above hull, turret	
AMMUNITION		commander	9 periscopes	top	0.524 m
20 mm, ready-use	250 (+ 150 stowed)	gunner	1 periscopic sight	DEPTH (below hull)	0.917 m
7.62 mm, ready-use	400 (+ 700 stowed)	WEIGHT (without		POWER SUPPLY	24 V
smoke grenades, ready-use	6 (+ 32 stowed)	crew)	1460 kg		

OTO Melara TPT Mk 4 12.7 mm Turret

Development

The OTO Melara TPT Mk 4 12.7 mm turret is mounted as standard on all the IAFVs built by OTO Melara for the Italian Army, but can also be installed on a wide range of other tracked and wheeled armoured vehicles such as the OTO Melara C13 family.

Description

The one-man, manually operated turret consists of three main parts: the actual cupola, the 12.7 mm M2 machine gun support and a three-part folding shield that protects the gunner.

The cupola itself consists of a fixed ring bolted to the roof of the vehicle on which is mounted the traversing part, machine gun mount and hatch covers.

The turret can be locked in any position for travelling; the locks are set every 12°.

The 12.7 mm M2 HB machine gun support is mounted on the forward part of the cupola and the weapon can be rapidly installed and removed.

The gunner is protected by three folding covers mounted on the sides and rear of the turret. These are opened and closed using a torsion bar system and when pushed up from within the turret the covers open and engage in position automatically.

Five periscopes are provided for all-round observation. Four forwardfiring, electrically operated smoke dischargers can be mounted either side of the turret.

Variants

Mk 3

Fitted with a 7.62 mm machine gun and mounted in the rear part of the armoured personnel carrier roof, this model is fixed.

Mk 5

Fitted with a 12.7 mm M2 HB machine gun, with M113 top hatch and five periscopes.

Mk 6

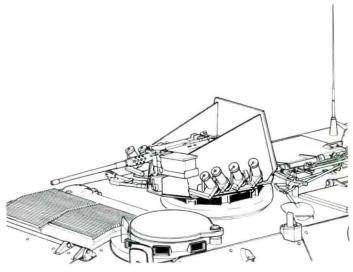
Fitted with a 12.7 mm M2 HB machine gun and only one periscope.

Mk 7

Fitted with a 7.62 mm machine gun, searchlight and five periscopes.

 ${\bf Status:}$ Production as required. The TPT Mk 4 12.7 mm turret is in service with the Italian and other armies.

Manufacturer: OTO Melara, via Valdilocchi 15, I-19100 La Spezia, Italy. Telephone: (0187) 530 111 Telex: 270 368 OTO I Fax: (0187) 530 669



OTO Melara TPT Mk 4 turret fitted with 12.7 mm M2 HB machine gun and smoke dischargers, with three hatches open

Breda Light Turrets

7.62 mm Hand-operated Light Turret

This one-man turret is of light alloy or steel construction and can be traversed by hand through a full 360° . It is armed with a 7.62 mm machine gun with manual elevation from -5 to $+25^\circ$ but it also has a limited traverse of 8° left and right. The turret has an optical sight for aiming the machine gun and seven periscopes are fitted in the sides. The machine gun is provided with 80 rounds of belted ammunition for ready use. Basic specifications of this turret are weight without machine gun 120 kg, height above hull top 430 mm, width 750 mm, swept radius of turret without gun 640 mm and swept radius of turret with machine gun 1.07 m. As an option a turret ventilation/fume extraction system can be fitted.

7.62 mm Power-operated Light Turret

This is armed with an externally mounted 7.62 mm machine gun provided with 80 rounds of belted ready-use ammunition. The weapon can be elevated from -10 to $+25^{\circ}$ at $40^{\circ}/s$ and traversed through a full 360° at $60^{\circ}/s$. Elevation and traverse are powered via a joystick. The weapon is aimed via a periscope from within the safety of the vehicle. Firing is automatically interrupted when the belt is almost empty to enable the gunner to attach a new belt from inside the vehicle. Basic specifications are weight including machine gun 150 kg, overall length with machine gun 1.17 m, diameter of mount 424 mm, height of mount above vehicle 335 mm and depth of mount below vehicle 500 mm.

7.62 mm Power-operated Anti-tank Turret

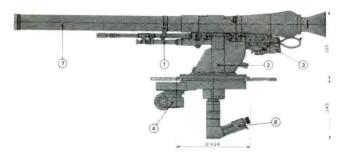
This is similar to the above but is also fitted with the Folgore anti-tank weapon to the left of the 7.62 mm machine gun. Once this has been fired the gunner has to leave the vehicle to reload. Basic specifications are weight with machine gun and Folgore anti-tank weapon 180 kg, overall length of the anti-tank weapon 1.8 m, height above hull roof with anti-tank weapon 395 mm and depth below vehicle roof 345 mm.

12.7 mm Power-operated Light Turret (T12.7FA)

This is armed with an externally mounted 12.7 mm M2 HB machine gun that is protected by a light alloy structure and uses a special aiming periscope assembly with a three section optical axis. The gun can be aimed and fired from within the safety of the vehicle. The weapon is fed from a belt containing 110 rounds of ready-use ammunition and has an elevation of



Breda 7.62 mm hand-operated light turret



Breda 7.62 mm power-operated anti-tank turret: (1) 7.62 mm machine gun (2) ammunition duct (3) firing solenoid (4) traverse drive (6) aiming periscope (7) Folgore recoilless gun

from -10 to $+50^\circ$ at 40° /s and turret traverse of 360° at 60° /s. Elevation and traverse are via servo motors controlled by a joystick. Basic specifications are weight inclusive of machine gun 210 kg, overall length with machine gun 1.69 m, diameter of base of mount 740 mm, height of mount and machine gun above roof of vehicle 600 mm, depth of mount below vehicle roof 560 mm.

12.7 mm Power-operated Anti-tank Turret

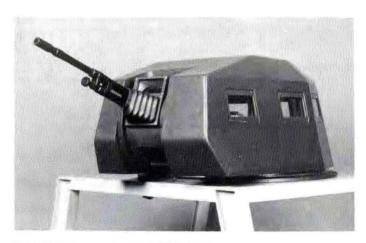
This is basically the previous turret fitted with a Folgore anti-tank weapon either side of the 12.7 mm machine gun with similar weapon elevation and turret traverse. Basic specifications are weight inclusive of machine gun and 100 belted ready-use rounds and Folgore anti-tank launchers 230 kg, overall length with machine gun and Folgore 1.8 m, diameter of base of mount 740 mm, height of mount and weapons above hull of vehicle 490 mm, depth of mount below vehicle 420 mm.

Folgore 80 mm Recoilless Gun on Rotating Cupola

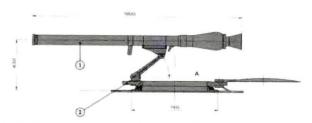
This cupola has a single-piece hatch cover opening to the rear and, mounted on the forward part of the ring slightly offset to the right, is a Folgore 80 mm anti-tank system with an elevation of +20° and a depression of -10°. The launcher can be in one of three positions, travelling locked to the cupola, firing, weapon raised to allow aiming and loading, weapon raised and displaced forward to allow loading of ammunition. A 7.62 mm or 12.7 mm machine gun can be mounted on the left side of the cupola if required. The weight of the kit, inclusive of the anti-tank launcher is 25 kg.



Breda 12.7 mm power-operated turret complete with aiming periscope assembly



Breda 7.62 mm power-operated light turret



Breda kit for installing Folgore 80 mm recoilless gun on rotating cupola: (1) Folgore recoilless gun (2) rotating cupola

Note: Breda is also involved with OTO Melara in co-producing the T 25 25 mm, TC 20 20 mm and 12.7 mm power-operated light turret (T12.7FA) previously described in this section.

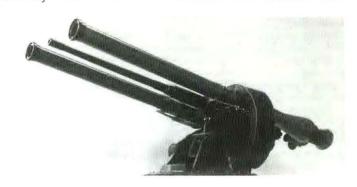
Status: In production.

Manufacturer: Breda Meccanica Bresciana SpA, Via Lunga, 2, I-25126

Brescasia, Italy.

Telephone: (030) 371911 Telex: 300 056 BREDAR I Fax: (030) 322115

Breda 12.7 mm power-operated anti-tank turret



NORWAY

NFT 25 mm MK 25 Model E Vehicle-Mounted Turret

Development

The MK 25 Model E 25 mm one-man gun turret is the result of further development of the Rh 202 20 mm gun turret and can be adapted to fit virtually any type of AFV such as the M113, Pbv 302 and Puma ICV. The turret has been fitted to the Hellenic Vehicle Industry's Leonidas 2 AIFV for trials purposes.

Description

The turret's main armament is an electrically fired Mauser MK 25 mm Model E automatic cannon with a dual-feed mechanism to allow ammunition selection according to target type. The gun may also be fired mechanically via a foot pedal. Two magazine boxes are fitted, an upper and a lower with 40 and 80 linked 25 \times 137 mm ready-use rounds. The magazines are both changeable to facilitate reloading.

Secondary armament is a 7.62 mm coaxial MG3 machine gun together with two triple banks of smoke dischargers mounted externally on the turret forequarters. A single 71 mm target illumination system can also be fitted as an option.



NFT 25 mm MK 25 Model E vehicle-mounted turret

Standard production turrets are delivered with a manual drive mechanism that uses two handcranks located in front of the gunner. They give the turret/gun 4° of movement per revolution. By depressing a foot pedal the gear ratio is instantly changed to give 12° of movement per revolution. A torque compensator is fitted to automatically balance the recoil forces when the guns are fired. The traverse handcrank is also fitted with the gun's electric triggering mechanism.

As an option the turret can be supplied in an electric servo-drive power control configuration to allow engagement of targets performing evasive manoeuvres. This consists of one two-axis joystick, one two-axis servo-amplifier and a combined manual/powered gearbox. The power-supply required is 24 V DC, The traversing speed is variable from a few-millirads/s to 90°/s. Full emergency manual backup is provided, in case of system failure.

The sight for ground targets is fitted to the turret hull with a movable prism coupled to the trunnion. Magnification is $\times\,8$. There are also three forward-facing and one rear-facing M17 unitary magnification prism periscopes for all-round observation. For anti-aircraft use there is an optical sight mounted on the gun cradle. The gunner must open his hatch to align his sight and to obtain improved vision when using this.

SPECIFICATIONS

CREW
BEARING OUTER
DIAMETER
ARMAMENT

AMMUNITION TRAVERSE

ELEVATION

COMBAT WEIGHT

OPTICS

1.200 m

1 × 25 mm cannon

1 × 7.62 mm MG

2 × triple smoke dischargers 120 × 25 mm ready use rounds 360°, manual at 4° or

12°/handcrank revolution

 -10° to +50°, manual at 4° or 12°/

handcrank revolution

 $1\times ground$ target sight with \times 8 magnification, $4\times M17$ unitary

prism periscopes 1 × anti-aircraft sight about 1000 kg

Status: Production as required.

Manufacturer: Norsk Forvarsteknologi AS (NFT), Manufacturing Division,

PO Box 1003, N-3601 Kongsberg, Norway.

Telephone: +47 3 73 82 50 Telex: 71491 vaapn n FAX: +47 3 73 85 86

Kvaerner-Eureka Armoured Launching Turret for TOW Missile Systems

Development

This turret has been designed by Kvaerner-Eureka and the Norwegian Army Material Command to launch the American Hughes TOW anti-tank missile. It has already been selected by the Norwegian Army (on an M113), the Swiss Army on the Panzerjäger 90 MOWAG Piranha (6 \times 6) chassis, the Canadian Army (on M113) and the Turkish Army (on the Turkish Armoured Combat Vehicle).

With this turret system the gunner is under full armour protection and new missiles can be loaded from the rear without the loader being exposed to small arms fire and shell splinters.

Kvaerner-Eureka Armoured Launching Turret on Panzerjäger 90, MOWAG Piranha (6 \times 6) armoured vehicle with two TOW missiles ready to launch



Description

The turret is of all-welded armoured steel construction with a single-piece hatch cover, and a single periscope mounted in the front of the turret for observation. On either side of the turret is the elevating armoured TOW launcher.

The Armoured Launching Turret has in its forward part the sight and guidance systems of the normal infantry version of the TOW system without any modifications. It is possible to re-assemble these with the tripod, traverse and elevating mechanism and the launcher tube of the original infantry TOW system and deploy the system away from the vehicle in a few minutes. The new hand controller used in the turret is very similar in operation to the original TOW controller. The turret is capable of firing Basic TOW, Improved TOW and TOW-2 missiles.

Time between the first missile impacting the target and the second missile being armed and ready for launching is two seconds. Reload time is about 40 seconds for both missiles with the turret in the loading position. Fire control interlocks prevent the arming of more than one missile at a time. The vehicle can be driven at full speed with both launchers armed, coming to a halt for firing.

SPECIFICATIONS

 CREW
 1 (gunner)

 ARMAMENT
 2 × TOW launchers

 AMMUNITION
 2 TOW ATGWs ready

 to launch

CONTROL traverse

 $\begin{array}{cc} 360^{\circ} \text{ at } 2^{\circ}/\text{s, track} \\ \text{elevation} & -15^{\circ} \text{ to } +15^{\circ} \text{ at } 3^{\circ}/\text{s} \end{array}$

 LENGTH
 1.5 m

 WIDTH
 1.06 m

 HEIGHT
 1.1 m

Status: In production for Turkey. In service with Canadian (licence built), Norwegian, Swiss (310) and Turkish armies.

360° at 9°/s, slew

Manufacturer: Kvaerner-Eureka A/S, Defence Products Section, Joseph Kellers vei, PO Box 38, Tranby, Norway, N-3401 LIER.

Licence production for the Canadian Armed Forces undertaken by the Linamar Group (qv).

PAKISTAN

Pakistan Ordnance Factories Twin 106 mm Recoilless Rifle Mount

Development/Description

The POF have developed a twin 106 mm recoilless rifle mount for use on the rear decking of the M113 APC. The system integrates a laser rangefinder into the existing sight of the 106 mm to replace the elbow telescope. This allows the range to be displayed for the gunner in the sighting optic which means he can apply the super-elevation and fire without having to look at more than one instrument.

The end results are an improvement in accuracy, a better view for the gunner of the area in which the target is located and an increase in effective engagement range of the 106 mm rifles from 1000 to 1500 m.

Status: Production. In service with the Pakistani Army.

Manufacturer: Pakistan Ordnance Factories (POF), Wah Cantonnement, Pakistan.

Telephone: (51) 66031-39 Telex: 5840 POFAC.PK Fax: (51) 584175



POF-manufactured twin 106 mm recoilless rifles mounted on the roof of an M113 APC

SPAIN

SANTA BARBARA TC-3 (A-1) 12.7 mm Turret

Development/Description

This turret has been designed by SANTA BARBARA for installation in light tracked and wheeled AFVs. It has been installed on most BMR-600 (6 \times 6) IFVs built by ENASA for the Spanish Army and for export (for example to Egypt on the BMR-600) and has also been fitted on several Spanish Army M113 APCs (designated TOA in Spain).

The 12.7 mm (0.50) M2 HB Browning machine gun is mounted externally and aimed by the gunner from within the vehicle using an ENOSA periscopic sight model PP-03 with an observation window of \times 1 (33° horizontal and 18° field-of-view vertical), an ENOSA aiming elbow telescope with a magnification of \times 3 (12°30' true field-of-view) and illuminated aiming graticule. Turret traverse and weapon elevation are manual and the machine gun is provided with 130 rounds of ready-use ammunition.

Before the ammunition belt has been fully expended a belt-end warning system works by interrupting electrical firing and lighting up a lamp in the electrical control box telling the gunner that a fresh belt must be attached.



SANTA BARBARA TC-3 (A-1) 12.7 mm turret fitted with panoramic ring and periscope either side of mount

In addition to the periscopic sight for aiming the 12.7 mm machine gun, there is a single ENOSA PO-100 periscope either side of the lower part of the mount angled slightly outwards.

As an option, a circular spacer containing eight vision blocks can be mounted between the top of the hull and the TC-3 mount to give the gunner a full 360° visibility without traversing the turret. The vision blocks in this version are designed to withstand protection from $7.62\,\mathrm{mm}\times51$ AP ammunition.

The TC-3 (A-1) can also accommodate smaller machine guns. A variant with an adaptor kit for a 7.62 mm machine gun and a special mooring circumference for the M113 APC has been developed at the request of Peru.



SANTA BARBARA TC-7/106 turret with two 106 mm M40 recoilless rifles

Variants

TC-3/ASP-30

This was shown for the first time in 1986 and is essentially the TC-3 with the 12.7 mm M2 machine gun replaced by the McDonnell Douglas Helicopter ASP-30 30 mm weapon fully described in the AFV Armament section.

This is a further development of the TC-3 (A-1) and is fitted with two 106 mm M40 recoilless rifles. Only one crew member has to expose briefly the upper part of his body to reload the weapons.

The gunner aims the rifles from within the vehicle with the reloading carried out through the roof hatch. Ten 106 mm reload rounds are carried in the vehicle in addition to a ready-use round in each of the rifles

Both turret traverse and weapon elevation are hydraulically controlled with the gunner's handle having special controls for fast target search (up to 15°/s for traverse and 10°/s for elevation) and accurate searching (minimum 0.3°/s on two axes).

The unity periscope sight and × 6 magnification surveillance sight are similar to those of the TC-3 (A-1).

Secondary armament comprises a 12.7 mm M2 HB heavy machine gun for self-defence plus a 12.7 mm spotting rifle on the right-hand recoilless gun.

Turret combat weight is 1000 kg with the height above roof being 0.85 m and the roof aperture diameter 0.745 m. Overall width is 0.796 m with a mooring circumference of 0.762 m.

Maximum elevation/depression of the recoilless rifles is -15° to +20°: Traverse is a full 360°

Optional equipment includes a Philips night sight and eight armoured panoramic vision blocks. The latter would add 150 kg to the turret's combat

AC-10/556 M-1

This is armed with a 5.56 mm CETME/Ameli machine gun which can be elevated from -15° to +68° with 100 rounds of ready-use ammunition, with the gunner having a rear-opening hatch cover.

The optional panoramic vision ring of the TC-3 (A-1) can be fitted. This contains eight armoured vision blocks which can withstand hits from 7.62×51 mm rounds. The weight of the ring is 105 kg, the diameter 0.762 m and the height 0.16 m. An OSC-500 250 W 100 m range can also be fitted.

Combat weight of the AC-10/556 M-1 is 250 kg. Overall width is 0.946 m, mooring circumference diameter is 0.762 m, roof aperture diameter is 0.745 m and height above roof is 0.44 m. The swept radius is 1.015 m.

AC-12/MILAN

To meet a Spanish Army requirement the AC-12 turret variant has been developed. This is similar to the TC-3 (A-1) but with the machine gun mount replaced by a firing post for the Euromissile MILAN ATGW. The 12.7 mm machine gun is retained as the secondary armament.

Status: TC-3 (A-1) in production. In service with the Spanish Army, and the armies of Egypt and the United Arab Emirates.

AC-10/556 M-1 -in production. In service with the Spanish Army, Spanish Civil Guard and the Saudi Arabian armed forces.

AC-12 - ready for production. Spanish Army evaluation trials complete with an order expected.

TC-7/106 - ready for production. Has been offered to a number of armies in Africa, the Middle and Far East and South America.

Manufacturer: SANTA BARBARA SA, Julian Camarillo, 32, E-28037 Madrid, Spain.

Telephone: (91) 585 0100 Telex: 44466 ENSB E Fax: (91) 585 0268

SPECIFICATIONS (TC-3 (A-1))

CREW 1 (gunner) ARMAMENT 1 × 12.7 mm MG AMMUNITION 130 CONTROL

traverse 360°, manual -15° to +40°, manual elevation **OPTICS** × 1 sight, × 3 (aiming) WEIGHT without weapon or ammunition 256 kg 307 kg with 12.7 mm MG DIAMETER 0.762 m HEIGHT OF TRUNNION 0.485 m AXIS

MAX EXTERIOR DIAMETER OF TURRET BASE 0.872 m MAX HEIGHT OVER VEHICLE ROOF

MAX SWEPT RADIUS DIAMETER OF HATCH ON VEHICLE ROOF

0.602 m 1.095 m

0.745 m

SANTA BARBARATC-9/OP and TC-17/CL Turrets

Development/Description

The TC-9/OP one-man power-operated turret has been designed for installation on internal security vehicles although it can also be used for convoy escort and counter-insurgency roles. The turret is of all-welded steel construction that provides protection from small arms fire and shell splinters, and the gunner is provided with a single-piece hatch cover that opens to the rear.

Mounted in the forward part of the turret is a MOWAG 40 mm grenade launcher that can fire smoke, CS gas or anti-barricade grenades. This can be elevated from -10° to +35°

Mounted externally on the right side of the turret is a 5.56 mm CETME Ameli machine gun which can be elevated from -15° to +60°. This is fed from a 500-round ammunition box inside the turret and can, therefore, be reloaded without the gunner leaving the turret. Turret traverse and weapon elevation are hydraulic with manual controls for emergency use

Mounted in the forward part of the turret roof is an ENOSA PP-03 periscope with × 1 vision for observation and × 3 vision with variable lighting graticule. To the right of the machine gun is a TV camera with a 15-180 f1.9 zoom lens which outputs to a high-resolution VHS and a 6 in (or optionally 9 in) TV monitor with a record facility mounted in the turret. In addition, there are six vision blocks, two on each side and two on the rear. Options include a 7.62 mm MG42 machine gun fed by two 250-round ammunition boxes, OSC-500 250 W spotlight with a range of 100 m, or a 150 W spotlight with a range of 800 m and a variable beam and infra-red filter.



TC-9/OP on Spanish Guardia Civil BLR armoured vehicle

Variants

700 kg

0.796 m

0.67 m

0.745 m

A simplified TC-17/CL variant has been produced. This retains the grenade launcher but no video, searchlight or machine guns.

SPECIFICATIONS (TC-9/OP)

CREW ARMAMENT 1 × grenade launcher 1 × 5.56 mm MG TRAVERSE 360°, powered/ manual 0.5 mils/s min, 16°/s max

FLEVATION -15° to +60° machine gun and camera grenade launcher -10° to +35°

both above at 0.5 mils/s min 10°/s max WEIGHT WITH **AMMUNITION** TURRET RING DIAMETER HEIGHT ABOVE HULL ROOF

HOLE REQUIRED IN VEHICLE ROOF

ATTACHED TO ROOF BY 16 SCREWS AROUND A CIRCUMFERENCE WITH DIAMETER OF 0.762 m

Status: TC-9/OP - production as required. In service with Spanish Guardia Civil (BLR). TC-17/CL- production as required. In service with Ecuadorean Police (25 turrets).

Manufacturer: SANTA BARBARA SA, Julian Camarillo, 32, E-28037, Madrid, Spain

Telephone: (91) 585 0100 Telex: 444 66 ENSB E Fax: (91) 585 0268

SANTA BARBARA TC-25/M242 Turret

Development

Under the offset agreement programme for the procurement of McDonnell Douglas EF-18 Hornet all-weather day and night jet fighters, Spain also bought 208 25 mm M242 Bushmaster Chain Guns in 1989. These are mounted on the ENASA VEC (6 × 6) Cavalry Scout Vehicle in an adapted OTO Melara two-man turret. The first units were installed under licence by SANTA BARBARA. The whole turret, known as the TC-25/M242, is now Spanish-built with deliveries underway to meet the 208 units ordered by the Spanish Army

The agreement with McDonnell Douglas gives SANTA BARBARA the right to export the Bushmaster armed turret without restriction.

The casing of the TC-25/M242 turret is made from all-welded ballistic steel plate which gives protection against 20 mm cannon fire from the front and small arms/grenade splinters all-round.

The commander is seated on the left of the turret and the gunner on the right. Both seats are adjustable with rear-opening roof hatches above them.

Main armament is a 25 mm M242 Bushmaster cannon with electrical control for elevation, traverse and firing. Two magazines beneath the cannon supply it with linked ammunition (typically 135 HE rounds in the lower magazine and 35 APDS rounds in the upper magazine).

The cannon operates entirely automatically using a transmission chain driven by an electric motor to control the operating cycle. The 25 \times 137 mm ammunition is rammed in by the bolt during the recoil. A double feed mechanism allows the two types of ammunition in the magazines to be selected and fired as required.

The secondary armament is a coaxial 7.62 mm MG3S machine gun, which is fed by a 250-round linked ammunition belt in a magazine to the left of the gun.

Six electrically salvo or independently fired 77 mm 50-60 m range smoke dischargers are fitted in rows of three on either side of the turret.

The optical system comprises an ENOSA P-204 × 1 and × 8 magnification periscope for the gunner and an ENOSA PP-03 \times 3 and \times 1 magnification periscope for the commander. There are also seven unitary PO-100 periscopes around the commander's cupola. A night vision system can be provided as an option.

SPECIFICATIONS

CREW ARMAMENT 2

1 x 25 mm M242 cannon

1 × 7.62 mm coaxial machine gun

6 × 77 mm smoke dischargers (in sets of

three)



SANTA BARBARA TC-25 two-man power-operated turret installed on Pegaso VEC (6 × 6) Cavalry Scout Vehicle of the Spanish Army

AMMUNITION

170 25 mm rounds (135 HE + 35 APDS) 250 7.62 mm rounds

TRAVERSE

6 x 77 mm Type HC smoke grenades 360°, powered/manual, min 1 mil/s, max 40°/s

FLEVATION WEIGHT

-10° to +50°, min 1 mil/s, max 35°/s

(combat without crew) **OPTICS**

1600 kg

commander 1 × PP-03 sight with × 1 and × 3 magnification, 7 × PO-100 × 1 magnification episcopes

gunner 1 × P-204 periscope with × 1 and × 8 magnification

Status: Production. In service with the Spanish Army (on VEC (6 × 6) Cavalry Scout Vehicles)

Manufacturer: SANTA BARBARA SA, Julian Camarillo, 32, E-28037

Madrid, Spain.

Telephone: (91) 585 0100 Telex: 44466 ENSB E Fax: (91) 585 0268

SANTA BARBARA TC-13/M242 Turret

Development

The TC-13/M242 turret is essentially a one-man simplified version of the TC-25/M242 turret produced to meet the requirements of more austere equipment needs. A number of countries have already shown interest in the design and the Spanish Army is due to evaluate it. The turret has been fitted to the Hellenic Vehicle Industry's Leonidas 2 AIFV for trials purposes.

Description

The casing of the TC-13/M242 turret is made from all-welded armour plate which is 20 mm thick in the front panels, 10 mm in the side and 8 mm in the rear and top. The front armour is resistant to 20 mm projectiles whilst allround protection is given against 7.62 mm armour-piercing rounds and grenade splinters.

The gunner is seated on the left and has a side-opening hatch cover in the roof above.

Main armament is a 25 mm M242 cannon with electrical control for elevation, traverse and firing. Two magazines beneath the cannon supply it with linked ammunition (typically 80 HE and 50 APDS rounds total).

The cannon operates entirely automatically using a transmission chain driven by a motor to control the operation cycle. The 25 \times 137 mm ammunition is rammed in by the bolt during the recoil. A double feed mechanism allows the two types of ammunition carried to be selected and fired as required.

The secondary armament consists of an electrically fired coaxial 7.62 mm MG42/MG3S machine gun fed by a 250-round linked ammunition belt in a magazine to the left of the gun. An alternative 7.62 mm model or a 5.56 mm calibre machine gun (for example the AMELI 5.56 mm) with 500 linked rounds can be requested.

SANTA BARBARA TC-13 turret armed with 25 mm McDonnell Douglas Helicopter Chain Gun installed on a Spanish built BMR 600 (6 × 6) APC

The turret traverse and gun elevation electric servo-mechanisms are driven by 24 V DC motors. Manual backup controls are provided.

Eight 76 mm or alternatively four 77 mm 50-60 m range electrically salvo or independently fired smoke dischargers are fitted in quad/pair assemblies on either side of the turret.

The optical system comprises a PERI-Z16 sight, with \times 1 and \times 6 magnifications, and five armoured unitary vision blocks around the turret sides and rear. An optional \times 8 magnification night sight is available.

Another option is a laser rangefinder which may be installed in the gun support area with the readout fed to a control/display panel located in front of the gunner. Accuracy is ±5 m.



SPECIFICATIONS

ARMAMENT

AMMUNITION

TRAVERSE

CREW

1 x 25 mm M242 Cannon

1 × 5.56 mm or 7.62 mm coaxial MG 4 × 77 mm smoke dischargers (in pairs)

130 25 mm rounds (80 HE + 50 APDS) 500 5.56 mm or 250 7.62 mm rounds

4 × 77 mm Type HC smoke grenades 360°, powered/manual, min 0.1 mils/s.

max 60°/s

FI EVATION WEIGHT (combat

without crew)

OPTICS

 $1 \times PERI-Z16$ sight with $\times 1$ and $\times 6$ magnification, 5 × unitary episcopes

-10° to +50°, min 0.1 mil/s, max 45°/s

Status: Ready for production. To be evaluated by Spanish Army.

Manufacture: SANTA BARBARA SA, Julian Camarillo, 32, E-28037 Madrid.

Spain

Telephone: (91) 585 0100 Telex: 44466 ENSB E Fax: (91) 585 0268

SWEDEN

Bofors Combat Vehicle 90 Turret

Some members of the Combat Vehicle 90 range of armoured fighting vehicles, being developed by Bofors and Hägglunds Vehicle, will be fitted with a two-man power-operated turret armed with a Bofors 40 mm 40/70B cannon. This has been developed by Bofors and is an addition to the 40 mm cannon, which is fully described in the AFV Armament section. It has a 7.62 mm machine gun mounted coaxially to the right, a bank of six electrically operated smoke dischargers mounted either side of the turret and two Bofors 71 mm Lyran illuminating launchers mounted on the turret roof towards the rear.

It is envisaged that this turret will be offered for installation on a wide range of other tracked and wheeled armoured vehicles, such as the M113, and be optimised for different roles, for example, anti-aircraft/anti-helicopter or engaging other armoured vehicles.

Description

The turret is of all-welded steel construction with the commander seated on the left and the gunner on the right, both with a single-piece hatch cover that opens to the rear. The commander's position is raised slightly above the gunner's position to give him all-round visibility. In addition to the periscopes for observation, both commander and gunner have a roofmounted periscopic sight for aiming the armament.



Combat Vehicle 90 fitted with Bofors-designed 40 mm turret

SPECIFICATIONS

CREW

ARMAMENT main

coaxial

SMOKE DISCHARGERS

OTHER

CONTROL

traverse

elevation

illuminating launcher 360° powered/manual

1 × 40 mm cannon

1 × 7.62 mm MG

 2×6

2 × 71 mm

-8° to +50°

TURRET WIDTH HEIGHT OF TURRET (from bottom of basket to top of sights)

1.52 m

Status: In production as part of the Combat Vehicle 90 programme.

Manufacturer: AB Bofors, S-69180 Bofors, Sweden.

Telephone: (46) 586 81000 Telex: 73210 Fax: (46) 586 58145

Hägglunds Vehicle Two-man 30 mm Gun Turret

Development/Description

The two-man 30 mm gun turret was originally designed for use on the Combat Vehicle 9030. The compact design turret can also be installed on a wide range of other tracked and wheeled armoured vehicles

The turret is of all-welded construction and is armed with the 30 mm Bushmaster II Chain Gun with coaxial 7.62 mm MG. If required, it can be adapted for the 30 mm Mauser Mk 30F cannon.

The commander sits on the left and the gunner on the right, each having an adjustable seat and a single-piece hatch cover. Turret traverse and gun elevation are electrically operated. The 30 mm gun is stabilised enabling both stationary and moving targets to be successfully engaged whilst the vehicle itself is moving.

The gunner has a Kollsman DNSR day/night sight with laser rangefinder and a ballistic computer. The commander has a SOPELEM M371 periscopic sight with a remote thermal display. Around the turret hatches, for general all round surveillance, are 11 periscopes (seven for the commander and four for the gunner).

A total of 12 electrically operated smoke dischargers are fitted on either side of the turret in banks of six.

SPECIFICATIONS

CREW ARMAMENT

main coaxial

smoke dischargers illumination launchers

AMMUNITION main

coaxial smoke dischargers illumination

TRAVERSE ELEVATION/DEPRESSION

OPTICS commander

aunner

STABILISATION/FIRE-ON-THE-MOVE WEIGHT TURRET RING DIAMETER

2 (commander and gunner)

1 × 30 mm cannon Bushmaster II

1 × 7.62 mm MG

 2×6

2 18 m

2 x 71 mm Lyran

275 ready use in the turret 400 ready use in the turret

360° electrical, manual backup -10° to +50°, manual backup

1 × day sight with remote thermal display, 7 × periscopes 1 × day/night sight with laser rangefinder, 4 × periscopes

3000 kg 1.75 m

Status: Prototype.

Manufacturer: Hägglunds Vehicle AB, S-89182 Örnsköldsvik, Sweden.

Telephone: +46 660 80000 Telex: HAEGG S 6051

Fax: +46 660 15190



Hägglunds Vehicle two-man 30 mm turret installed on CV90 chassis

Hägglunds Vehicle Two-man 25 mm Gun Turret

Development/Description

The two-man turret was originally designed by Hägglunds Vehicle for use on a wide range of other tracked and wheeled armoured vehicles.

The vehicle commander sits on the left and the gunner on the right side, each with an adjustable seat and a one piece hatch cover.

The turret is made of all welded armoured steel and is armed with the 25 mm M242 McDonnell Douglas Chain Gun but it can also be adapted for the 25 mm Oerlikon-Contraves KBA or Mauser MK 25 cannon types. Traverse and gun elevation are operated mechanically by the gunner. The gun is fired electrically with manual backup. The gunner can select either single shots or full automatic fire.

A total of 12 electrically operated smoke dischargers are fitted either side of the turret in banks of six. On the turret roof are two Bofors 71 mm Lyran illuminating launchers.

Around the turret hatches, for all round general surveillance, are 13 M17 unity vision periscopes (eight for the commander and five for the gunner). The gunner has a SOPELEM M371 periscope sight with a × 6 magnification channel for ground targets and a × 1 magnification channel for air targets and general observation.

Optional equipment includes electrically powered gun controls, a gunner's day/night sight and a coaxial machine gun.

SPECIFICATIONS

CREW ARMAMENT main

coaxial smoke dischargers

illumination launchers

AMMUNITION 25 mm

smoke dischargers illumination CONTROL

depression/elevation

slew ratio traverse min slew ratio max slew ratio 2 (commander and gunner)

1 x 25 mm M242 cannon

optional MG 2×3

2 × 71 mm Lyran

380 (170 AP plus 210 HE)

36 20

-10° to +50°, manual

10°/s 360°, manual 7.5°/s 22.5°/s

OPTICS commander gunner

TURRET RING DIAMETER WEIGHT (total)

8 × M17 periscopes

1 × SOPELEM M371 periscope

5 × M17 periscopes

1.75 m 2400 kg

Status: Ready for production.

Manufacturer: Hägglunds Vehicle AB, S-89182 Örnsköldsvik, Sweden.

Telephone: (46) 660 80000 Telex: HAEGG S6051

Fax: (46) 660 15190



Combat Vehicle 90 fitted with Hägglunds Vehicle two-man 25 mm turret

Hägglunds Vehicle 25 mm Gun Turrets

Development/Description

These turrets are essentially a Hägglunds Vehicle modified 20 mm gun turret HS 804 fitted with an Oerlikon-Contraves KBA or Mauser MK 25 25 mm cannon. The gunner has an adjustable seat and a single-piece circular hatch cover that opens to the rear. Three periscopes are mounted in front of the hatch and a fourth behind it. A sight with a magnification of x 8 mounted in the forward part of the turret is used to engage ground targets. For aerial targets the gunner uses an externally mounted reflex sight. The empty 25 mm cartridge cases are ejected externally through a hatch in the right side of the turret.

Status: Ready for production.

Manufacturer: Hägglunds Vehicle AB, S-89182 Örnsköldsvik, Sweden.

Telephone: (46) 0660 80000 Telex: HAEGG S6051

Fax (46) 0660 15190



Hägglunds Vehicle 25 mm turret with Mauser 25 mm MK 25 cannon

SPECIFICATIONS Version	Oerlikon-Contraves KBA 25 mm	Mauser 25 mm MK 25	Version	Oerlikon-Contraves KBA 25 mm	Mauser 25 mm MK 25
CREW	1 (gunner)	1 (gunner)	WEIGHT		
ARMAMENT			(including gun)	820 kg	1030 kg
main	1 × 25 mm KBA cannon	1 × 25 mm MK 25 cannon	DIAMETER (at base) SWEPT RADIUS	1.08 or 1.2 m	1.25 m
coaxial (optional) SIGHTING	1 × 7.62 mm MG sight with × 8	1 × 7.62 mm MG sight with × 8	(gun and turret) HEIGHT	2.58 m	2.54 m
SUPPLEMENTARY VISION	magnification 4 periscopes	magnification 4 periscopes	(above vehicle roof) AXIS OF FIRE	0.585 m	0.61 m
CONTROL	W. December 1 and 1		(above vehicle roof)	0.23 m	0.23 m
traverse elevation	360° manual 2-speed -10° to +50°	360° manual 2-speed -10° to +50°			

Hägglunds Vehicle 20 mm Gun Turret Rh 202

This turret was developed by Hägglunds Vehicle and the Norwegian company of Kongsberg Våpenfabrikk A/S to meet the requirements of the Norwegian Army. It is installed on M113A1 APCs which are designated NM 135. First production turrets were completed in September 1980.

Description

The one-man turret is made of all-welded steel and the gunner has an adjustable seat and a single-piece hatch cover that opens to the rear. Three periscopes are mounted in front of the hatch cover and a fourth behind it. A sight with a magnification of × 8 mounted in the forward part of the turret is used to engage ground targets. For aerial targets the gunner uses the external sight mounted parallel to the 20 mm cannon.



Hägglunds Vehicle 20 mm gun turret Rh 202 on M113 APC showing externally mounted 7.62 mm machine gun and smoke dischargers

Main armament comprises a dual-feed German 20 mm MK 20 Rh 202 cannon with the empty cartridge cases ejected externally through a hatch in the right side of the turret. Mounted on the right side of the turret is a 7.62 mm MG3 machine gun which moves in elevation with the main armament. There are three smoke dischargers mounted on the forward part of the turret either side of the 20 mm cannon.

SPECIFICATIONS

CREW	1 (gunner)
ARMAMENT	1 × 20 mm cannon
	1 × 7.62 mm MG
AMMUNITION	200 rounds of 20 mm
AMMONITION	
	in turret, 400 rounds of
	7.62 mm in turret
SMOKE DISCHARGERS	3 mounted either side
	of main armament
SIGHTING	sight with × 8
	magnification
SUPPLEMENTARY	
VISION CONTROL	4 periscopes
traverse	360° 2-speed manual
elevation	-10° to +50° manual
WEIGHT	TO TO TOO Manda
	850 kg
(including gun)	0
DIAMETER (at base)	1.2 m
SWEPT RADIUS	
(gun and turret)	2.3 m
HEIGHT	
(above vehicle roof)	0.605 m
AXIS OF FIRE	
(above vehicle roof)	0.235 m

Status: In production. In service with the Norwegian Army.

Manufacturer: Hägglunds Vehicle AB, S-89182 Örnsköldsvik, Sweden. Telephone: (46) 0660 80000 Telex: HAEGG S6051 Fax (46) 0660 15190

Hägglunds Vehicle 20 mm Turret HS 804

This turret was developed by Hägglunds Vehicle in the early 1960s for the Pbv 302 full tracked APC which entered service with the Swedish Army in 1966. It is also installed on the Hägglunds Vehicle Bgbv 82 ARV which was also produced for the Swedish Army. In addition, the company has supplied large numbers to the Swiss Army for its M113A1 APCs (called the Schützenpanzer 63) which, when fitted with them, are known as the Schützenpanzer 63/73. The turret is suitable for installation on most types of AFV and has already been installed on the Brazilian ENGESA EE-11 Urutu APC.

Description

The one-man turret is made of all-welded steel with the gunner provided with an adjustable seat and a single-piece hatch cover that opens to the rear. Three M17 periscopes are mounted forward of the hatch cover and a fourth behind it. The sight with a magnification of \times 8 mounted in the forward part of the turret is used to engage ground targets. For aerial targets the gunner uses the external sight mounted parallel to the 20 mm cannon.

Main armament consists of a Hispano-Suiza 804 cannon with a cyclic rate of fire of 750 rds/min. This weapon, which is no longer in production, is fed from a 10-round magazine (holding APT rounds) or a 135-round (HE) belt, the empty cartridge cases being ejected externally through an aperture which opens as soon as firing begins.

Status: Production as required. In service with Gabon, Sweden and Switzerland.



Hägglunds Vehicle 20 mm turret HS 804 fitted to Brazilian built EE-11 Urutu (6 × 6) APC delivered to Gabon

Manufacturer: Hägglunds Vehicle AB, S-89182 Örnsköldsvik, Sweden. Telephone: (46) 0660 80000 Telex: HAEGG S6051 Fax: 0660 15190

SPECIFICATIONS

CREW ARMAMENT AMMUNITION

HE

OPTICS main

supplementary

1 belt of 135 rounds 5 10-round magazines

1 × 20 mm cannon

in turret

1 (gunner)

sight with × 8 magnification 4 periscopes

CONTROL

elevation
WEIGHT (including gun)
DIAMETER (at base)
SWEPT RADIUS
(gun and turret)

360° manual, 2-speed: 4° and 12° per rev -10° to +50° manual 600 kg 1.08 m

1.625 m

HEIGHT

(above vehicle roof) AXIS OF FIRE (above vehicle roof) POWER SUPPLY 0.48 m

0 285 m

24 V DC via slip ring

UNITED KINGDOM

VSEL GBT 155 155 mm Gun Turret

Development

The Vickers Shipbuilding and Engineering Limited (VSEL) GBT 155 155 mm. Gun Turret has been produced as a result of the company's involvement in the international FH-70 artillery howitzer project. Research has shown that there is a market for a modular 155 mm artillery gun turret that can be fitted into virtually any AFV heavy enough to withstand the recoil forces of a 155 mm howitzer. The prototype turret was developed and produced during 1981 and has since undergone successful static and chassis-mounted firing trials. The system has undergone a series of trials with the Indian Army, mounted on a Vijayanta MBT chassis.

Description

The GBT 155 is a modular design intended for fitting directly onto almost any modern main battle tank chassis. To date firing/mobility trials have been completed on Centurion, Chieftain, Challenger 1 and Vickers Mk 3 chassis.

The turret structure is armoured steel, constructed to provide strength and stiffness and ensure protection against small arms fire and shell splinters.

Ground level access to the fighting compartment is provided by local modifications to the chassis. Access hatches in the turret sides provide additional entry points for the crew and there is also a hatch in the commander's cupola.

The magazine at the rear of the turret stows 31 projectiles and incorporates simple indexing mechanisms which transfer the projectiles to a central point where they are manually withdrawn and placed on the loading tray. The sealed containers mounted above the shell magazine house 21 propellant charges with a further 11 at the front left of the turret. Additional ammunition can be stowed within the chassis, the quantity of which depends on the chassis employed.

The turret has a crew of four with the layer at the forward right, the commander behind and two loaders on the left.

The ordnance, cradle and saddle design is such that the barrel can easily be withdrawn from the front of the turret leaving the breech in place. In addition, the whole of the elevating mass, complete with saddle, can be quickly removed from the turret leaving all other turret-mounted equipment intact.

The recoil system has two diametrically opposed buffers and one recuperator, each with its own integral reservoir to reduce external piping and space requirements. The system is protected by an easily removed armoured cover.

The ordnance is a Royal Ordnance 155 mm 39-calibre barrel, with a vertical sliding split-block breech ensuring positive obturation, a double-baffle muzzle brake and a fume extractor. The ordnance conforms to the Quadrilateral Ballistic Agreement governing the standardisation of 155 mm ordnance and ammunition between the UK, USA, Germany and Italy.

The new design of self-obturation breech mechanism combines the rapid action of a sliding breech-block with a Crossley Pad obturator to provide a positive seal. The breech can be operated in both manual and semi-automatic modes and, in the latter, runout energy is used to open the breech. Both the German DM191A1 and the American M82 percussion igniter tubes can be used. The breech is connected to the barrel by a conventional interrupted screw-thread.

The barrel is machined from an ElectroSlag Refined (ESR) forging, of monobloc construction and is autofrettaged.

The howitzer can fire the full range of ammunition intended for the FH-70 and the M198 to a range of 24 700 m with standard projectiles and to 31 500 m with base bleed projectiles.

Due to the weight of 155 mm projectiles a semi-automatic loading system has been incorporated at the rear of the elevating mass to enable a rapid burst rate of fire to be achieved and a high rate of continuous fire to be sustained. This system provides a burst rate of three rounds in 13 seconds and an intense rate of six rds/min. This equipment comprises a loading tray and power rammer for loading the projectiles. The propellant charges are much lighter than the shells and are manually loaded.

Ammunition can be taken from either the onboard stowage or from an external source. Suitably positioned hatches in the chassis provide access

for this purpose and additional hatches in the turret provide alternative routes for use in an emergency.

Power for the loading system is provided by a small hydraulic powerpack installed in the front left corner of the turret. The electric motor driving this pack is identical to the motors used in the traverse and elevation drives.

Elevation and traverse motions are achieved using identical electric motors driving through gearboxes onto an elevation arc and a traversing rack respectively. Both motions are controlled by the layer's two-axis joystick. The commander has an override control in traverse only for designating targets in the direct fire role. Manual backup for both motions is provided by means of non-backdriving handwheels.

As the barrel is muzzle heavy a nitrogen charged gas cylinder is used to provide balance over the full elevation range of -5° to $+70^{\circ}$. Compensation equipment is fitted to allow for changes in ambient temperature.

The system is operated on conventional external optical reference principles and is fully compatible with standard artillery procedures. Overall accuracy and ease of operation are improved over the traditional cross levelling systems and, due to the feature of auto-lay, relaying between rounds is very rapid. The initial 'coming into action' procedures of passing the line with director recording 'Gun Aiming Post' (GAP) positions and the initial gun lay procedure are accomplished very quickly, simply by following the procedure indicated by the illuminated push buttons on the computer control panel.

Inertial navigation and auto-orientation can be provided as an option which will afford a full vehicle autonomous operation capability.

For direct fire against targets up to 2000 m away, a day/night sight is mounted on the elevating mass adjacent to the layer. The graticule is calibrated for range and crossing target velocity and, since the layer has both elevation and traverse controls, simple aiming of the gun can be achieved.

The power supply for all turret services is provided by a turret-mounted battery pack which is charged by the chassis APU. This obviates the need to run the vehicle main engine during fire missions.

An extractor fan is fitted as standard to the fighting compartment to remove any residual fumes and to provide adequate ventilation and air circulation for the crew.

The GBT 155 turret has been designed as a basic weapon system to meet the requirements of most customers and allows the choice of fire control equipment and communications by the customer. Optional extras include fire detection and fighting equipment, smoke dischargers and airconditioning.

Besides the chassis already trialled, possible carriers for the GBT 155 turret include the Leopard I, M48, M60 and chassis of former Soviet design. Options for the turret include inertial navigation for gun autonomy and barrel lengths of up to 52 calibres for ranges beyond 40 km.



VSEL GBT 155 155 mm gun turret on Vickers Mark 3 MBT chassis

4 + 1 (driver)
4.26 m 8.63 m 3.1 m
1.325 m 1.515 m 13 500 kg -5° to +70° at 10°/s 360° at 10°/s layer's joystick (commander has override)

with base bleed projectile MIN RANGE
SECONDARY ARMAMENT
EXTERNAL REPLENISH- MENT SYSTEM TURRET PROJECTILE STOWAGE CAPACITY TURRET CHARGE STOWAGE CAPACITY INTERNAL PROJECTILE HANDLING SYSTEM

MAIN ARMAMENT

MAX RANGE

	angle)
RY ARMAMENT	1×7.62 mm or
	1 × 12.7 mm MG
REPLENISH-	
STEM	manually assisted
ROJECTILE	
E CAPACITY	31
HARGE	
SE CAPACITY	32
PROJECTILE	
IG SYSTEM	manually assisted

SHELL LOADING SYSTEM RATES OF FIRE Burst Intense Sustained (one hour)

automatic 3 rounds in 13 s 6 rds/min 2 rds/min **ELECTRICAL SYSTEM** 24 V/48 V

Status: Ready for production.

Manufacturer: Vickers Shipbuilding and Engineering Limited,

Barrow-in-Furness, Cumbria LA14 1AF, UK. Telephone: (0229) 823366 Telex: 65411 VSEL G

Fax: (0229) 823366

1 × 155 mm 24 700 m

2500 m (high

31 500 m

Alvis 90 mm Turret

Development

Derived from the Alvis 76 mm turret (qv) the Alvis 90 mm turret is mounted on the Scorpion 90 variant of the Alvis Scorpion CVR(T) vehicle in service with Malaysia, Nigeria, Togo and Venezuela. It is also suitable for many other types of tracked and wheeled AFVs with a minimum weight of seven tonnes

Description

The turret is made of all-welded aluminium with the commander on the left of the gun and the gunner on the right, both with a single-piece hatch cover that opens to the rear.

The turret is mounted on a 1390 mm diameter Roballo race giving 360° traverse. Electrical power traverse and elevation is available for the gunner with an override facility for the commander. As an option electrohydraulic power traverse and elevation are available.

The commander has seven × 1 magnification forward sloping window periscopes and a roof-mounted Avimo NV53C combined day/night sight in front of his hatch cover with magnifications of × 1/× 8 for the day channels and \times 7.1 for the image intensifier night vision channel.

The gunner has two × 1 magnification forward sloping window periscopes and an Avimo NVL53C combined day/night sight with an integrated



Scorpion 90 which is armed with a 90 mm Cockerill Mk III gun

Nd-YAG 1.064 µm wavelength laser rangefinder. The daylight channel magnifications are × 1 and × 8 respectively with × 7.1 magnification for the image intensifier night vision channel.

The main armament is a rifled Cockerill 90 mm Mk III gun with an effective range of between 1200 to 2400 m depending upon the ammunition type. A total of eight ready-use rounds are carried in the turret.

A coaxial 7.62 mm GPMG is fitted to the left of the main gun as secondary armament with two sets of four electrically fired 66 mm smoke dischargers covering a 160° frontal arc, mounted externally on either side of the turret front. These launchers can be configured to fire 66 mm fragmentation grenades as an option.

SPECIFICATIONS

CREW	2 (commander/gunner)
DIMENSIONS	
length (turret rear bin to muzzle)	4.785 m
width (overall including stowage bin)	2.210 m
height (turret mounting face to	
top of commander's sight)	0.714 m
ARMAMENT	1 × 90 mm Cockerill Mk III gun
	1 × 7.62 mm MG
	2 × quadruple 66 mm smoke
	dischargers
AMMUNITION	8 × 90 mm rounds
	400 × 7.62 mm rounds
	16 × smoke grenades
TRAVERSE	360°
EL ELIATION!	004- 000

ELEVATION -8° to +30° **OPTICS** commander

1 × NV53C combined day/night sight, 7 × unitary vision

periscopes

1 x NV53C combined day/night sight with integral laser rangefinder, two unitary vision

periscopes

COMBAT WEIGHT 2238 kg (without crew POWER SUPPLY 28.5 ±0.25 V DC

Status: Production (over 100 produced to date - 1 January 1993). In service with Malaysia, Nigeria, Togo and Venezuela.

Manufacturer: Alvis Limited, The Triangle, Walsgrave, Coventry, West Midlands CV2 2SP, UK.

(A member of the United Scientific Group.)

Telephone: (0203) 535455 Telex: 31459 Fax: (0203) 539280

Alvis 76 mm Turret

Development

This turret is mounted on the Alvis Scorpion CVR(T) vehicle in service with Belgium, Brunei, Honduras, Iran, Ireland, New Zealand, Nigeria, Oman, Philippines, Spain, Tanzania, Thailand, United Arab Emirates and the United Kingdom. It is also suitable for many other types of tracked and wheeled AFCs and has so far been bought by Australia and Canada

In the Australian Army the turret has been mounted on M113A1 APCs for fire support use; 48 are in service, three prototypes and 45 production

In the Canadian Armed Forces it is mounted on the Wheeled Fire Support Vehicle Cougar (195) which is a Swiss MOWAG Piranha (6 × 6) vehicle manufactured in Canada by the Diesel Division of General Motors Canada

Description

aunner

The turret is made of all-welded aluminium with the commander on the left and the gunner on the right, both with a single-piece hatch cover that opens to the rear. The commander has seven periscopes and a roof-mounted sight in front of his hatch cover with a magnification of \times 1 and \times 10. The roof sight is capable of limited rotation allowing an approximately 85° horizontal field-of-view. The gunner has two periscopes and a roof-mounted sight with magnifications of \times 1 and \times 10. Mounted to the right of the main armament is a passive night sight. The image intensifier tube is protected from the effect of gun muzzle flash by a flash shutter that is operated electrically from the gun firing circuit. When high magnification is selected an illuminated ballistic graticule with brightness control is automatically injected into the optical system. The exposed objective window is cleaned by a wiper and washer and the sight is protected by an armoured cover with a door which is kept closed when the sight is not in use. Alternative sighting systems, supplied by Alvis, can be fitted. These incorporate day/night vision with an integral laser rangefinder, which eliminates the separate passive sight installation.

Main armament consists of a Royal Ordnance L23 76 mm gun which is a lighter version of the L5 76 mm gun used in the Saladin armoured car and fires a wide range of fixed ammunition, details of which are given in the *Ammunition* section. The gun has an elevation of +35° and a depression of -10°, turret traverse being 360°. Elevation and traverse are both manual but a power traverse and/or elevation system can be installed if required. A 7.62 mm machine gun is mounted coaxially to the left of the main armament and can be used as a ranging machine gun. Mounted either side of the turret is a four-barrelled electrically operated smoke discharger. The radios are behind the commander and gunner and a stowage box is mounted externally on the rear of the turret. Side bins can be fitted.

Further Product Improvements are now available including improved fume extraction, digital traverse indicator and turret lock. A revised turret basket based upon improvements from the 90 mm Alvis turret is also available and includes the latest seats, footrests, insulation panels and controls.

Status: In production (approximately 2000 produced to date - 1 January 1993). In service with Australia, Canada and the 14 countries listed in Development.

Manufacturer: Alvis Limited, The Triangle, Walsgrave, Coventry, West Midlands CV2 2SP, UK.

(A member of the United Scientific Group.)

Telephone: (0203) 535455 Telex: 31459 Fax: (0203) 539280



Alvis Scorpion Combat Vehicle Reconnaissance (Tracked) is fitted with an Avis turret armed with a 76 mm gun

Alvis 30 mm Turret

Development

The Alvis 30 mm turret was designed in conjunction with the British Ministry of Defence for use on the Scimitar variant of the CVR(T) Scorpion. Other vehicles that have been fitted/trialled with the turret include the FMC M113 APC, Panhard (6 \times 6) designs, Panhard AML 60/90, FV432 APC, Stormer and the SIBMAS (6 \times 6) APC.

Description

The turret is made of all-welded aluminium with the commander on the left of the gun and the gunner on the right, both with a single-piece hatch cover that opens to the rear.

The turret is mounted on a 1390 mm diameter Roballo race giving 360° traverse. A two-speed manual traverse gear is fitted as standard with electrically powered traverse and commander override capability as an option. A digital 360° traverse indicator unit may also be fitted.

The commander has seven × 1 magnification forward sloping window periscopes and a binocular × 10 magnification (No 57 Mk 2) with lever introduced × 1 magnification, limited traverse and 30 mm graticule. The Avimo NVC53C combined/day night assembly can be fitted as an optional sight.

The gunner has two \times 1 magnification forward sloping window periscopes and a No 52 Mk 1 binocular day/passive night sight with fixed eyepiece systems and \times 1 and \times 10 magnifications. An optional sight is the Avimo NVL53 combined day/night assembly with an integrated laser rangefinder. The objective systems elevate and depress with the gun.

The main armament is a single shot self-loading 30 mm L21A1 RARDEN cannon with an automated sliding breech. The recoil operated gun is fed from three-round clips and is capable of firing bursts of up to six rounds. A total of 60 ready-use rounds are carried in the turret.

A coaxial 7.62 mm GPMG is fitted to the left of the main gun as secondary armament, with two sets of quadruple electrically fired 66 mm smoke dischargers fitted externally on the turret forequarters. These launchers can be configured to fire 66 mm fragmentation grenades as an option.

SPECIFICATIONS

CREW
DIMENSIONS
length (rear bin to end of gun)
width (overall including stowage bins)
height (turret mounting face to top
of commander's sight)
ARMAMENT

2 (commander/gunner)

4.470 m 2.210 m

0.714 m

1 × 30 mm L21A1 cannon

1 × 7.62 mm MG

2 × quadruple 66 mm smoke dischargers

ELEVATION OPTICS commander

AMMUNITION

TRAVERSE

gunner

COMBAT WEIGHT (without crew) POWER SUPPLY 60×30 mm rounds 400×7.62 mm rounds

16 × smoke grenades 360°

-10° to +35°

1 × No 57 Mk 2 sight, 7 × unitary vision periscopes

1 × No 52 Mk 1 day/or night sight,

2 × unitary vision periscopes

1654 kg 28.5 ±0.25 V DC

1993). In service with Belgium (on Scimitar), Honduras (on Scimitar) and the UK (RAF and Army on Scimitar).

Status: Production as required (over 500 produced to date - 1 January

 $\begin{tabular}{ll} \textbf{Manufacturer:} & \textbf{Alvis Limited, The Triangle, Walsgrave, Coventry, West Midlands CV2 2SP, UK. \end{tabular}$

(A member of the United Scientific Group.)

Telephone: (0203) 535455 Telex: 31459 Fax: (0203) 539280



Alvis Scimitar is fitted with Alvis 30 mm turret

Marconi Marksman Twin 35 mm Anti-aircraft Turret

Development

The Marksman twin 35 mm all-weather, day/night, anti-aircraft turret has been developed as a private venture by Marconi Radar and Control Systems. Development started in 1983 and the first prototype, of mild steel construction, was shown in public for the first time at the 1984 British Army Equipment Exhibition on a Vickers Mk 3 MBT chassis. The second prototype, of all-welded steel armour construction, completed final weapon system trials early in 1986. The turret shell was built by Vickers Defence Systems of Newcastle-upon-Tyne while the 35 mm KDA cannon and the ammunition transfer systems were provided by Oerlikon-Contraves.

The Marksman turret has been designed for installation on a wide range of tank chassis including the T-54/T-55/T-72, Type 59, M47/M48/M60, Chieftain, Centurion, Challenger 1, AMX-30 and the Vickers Mk 3. All that is required to fit Marksman on a tank chassis is an adaptor ring and a simple electrical interface to enable the turret crew to communicate with the driver in the hull. No adaptor is required when fitting the Marksman turret on a former Soviet T-series chassis.

To date, the Marksman turret has been successfully trialled both in the UK and overseas on seven different tank hulls in a variety of environmental and climatic conditions ranging from -35°C to $+40^{\circ}\text{C}$. The trials have shown that the system can be mounted on even the smallest MBT hull in about two hours with virtually no effect on its automotive capability.

In 1988 Finland placed an order for an initial quantity of Marksman turrets plus ancillary equipment for installation on T-54/T-55 MBT chassis. They will be used to provide protection for the Finnish Army's armoured brigade. First production turrets for Finland were completed in 1991. Since then a further order has been placed by Finland for delivery in 1993.



Marksman twin 35 mm anti-aircraft turret installed on Centurion MBT chassis (left) and Challenger 1 MBT chassis (right)

Description

The turret is of all-welded steel construction which provides complete protection against 14.5 mm API projectiles over the frontal arc and against 7.62 mm armour-piercing projectiles over the remainder of the turret. Protection is also provided against 155 mm airburst artillery projectile splinters.

The commander sits on the left and the gunner on the right, with observation periscopes to their front, sides and rear. Each crew member also has a roof-mounted gyrostabilised sight with magnifications of \times 3 and \times 10 for optical engagement of air and ground targets, and the gunner's sight also incorporates a laser rangefinder.

Turret traverse and weapon elevation are electric, with manual controls for emergency use. Mounted in the turret rear is an auxiliary diesel generator so obviating the need for a generator in the hull of the tank.

Main armament consists of two Oerlikon-Contraves 35 mm KDA cannon mounted on either side of the turret on large diameter bearings, each of which has 230 rounds of anti-aircraft and 20 rounds of anti-tank ammunition. The ammunition is containerised with a reload time of between five and 10 minutes.

Mounted on the turret rear is the highly ECM resistant 400 series radar which uses a single antenna for surveillance and tracking. This rotates at 60 rpm, operates in the X/J-band and has a range of 12 km in the surveillance mode. The digital fire control system consists of the fire control computer, transmitter, synthesiser, signal processing unit, control console, data extraction unit and radar power amplifier. The fire control system is capable of full automatic operation, the gunner only needing to press the fire button. A gun and radar stabilisation is fitted allowing surveillance and surface engagements on the move.

The turret is fitted with an air-conditioning unit and a bank of electrically operated smoke dischargers is fitted on each side. As an option an NBC system can also be installed.

SPECIFICATIONS

CREW	2 (commander and
	gunner)
DIMENSIONS	
overall length with guns	
radar up	7.12 m
radars stowed	7.585 m
overall width	3.45 m
overall height	
radar up	2.705 m
radar down	1.910 m
TURRET RING DIAMETER	1.99 m
ARMAMENT	2 × 35 mm cannon
AMMUNITION	
anti-aircraft per barrel	230
anti-tank per barrel	20
CONTROL	
traverse	360°, electric, at up to 60°/s
elevation	-10° to +85°, electric, at 60°/s
WEIGHT	11 000 kg

Status: Production as required. First three production turrets were delivered to Finland late in 1991.

Manufacturer: Marconi Radar and Control Systems Limited, Weapon Systems Division, Leicester LE3 1UF, UK. Telephone: (0533) 871481 Telex: 34551 GECNPL-G

Fax: (0533) 871746

Vickers Warrior 30 mm Turret

Development

In 1978 Vickers Defence Systems was appointed by GKN Defence to design and build prototype turrets for the British Army's new mechanised infantry combat vehicle for the 1980s, the MCV-80. This turret was to mount the RARDEN 30 mm cannon and to be suitable for one- or two-man operation. By 1983 Vickers had manufactured nine prototype turrets which were extensively tested and initially accepted in 1984. The following year saw the renaming of the MCV-80 as the Warrior. First production turrets were completed in 1986 to coincide with the completion of the first Warrior chassis produced by GKN Defence. By late 1992 Vickers Defence Systems had completed over 520 Warrior turrets for GKN Defence.

Description

The turret is produced from steel armour plate and castings and is mounted on a high accuracy, low friction roller race. Power traverse is provided with manual controls for traverse and elevation. The crew and ready-round ammunition are carried on a frame which rotates with the turret. Electrical supplies and communications between the hull and turret are carried by a rotary base junction or slip ring.

The commander sits on the right of the gun from where he can command the vehicle or dismount quickly through the vehicle to command the infantry. The gunner sits on the left of the gun where he can load and fire it, whether or not the commander is on board.



GKN Defence Warrior mechanised combat vehicle which is fitted with Vickers turret armed with 30 mm RARDEN cannon

Main armament of the turret is the 30 mm L21A1 RARDEN cannon. This is a recoil-operated, self-loading weapon capable of firing repetitive shots and short bursts of up to six rounds with a cyclic rate of 80 rds/min. Ammunition for this gun is supplied in three-round clips which allows more rounds to be stowed in a limited space than rounds supplied in large boxes.

Mounted coaxially to the left of the 30 mm RARDEN cannon is a McDonnell Douglas Helicopter 7.62 mm Chain Gun. The most common cause of misfire, a dud round, does not affect this weapon as the misfired round is ejected from the vehicle automatically without interrupting firing.

Both weapons eject their spent cartridge cases from the vehicle thus preventing toxic fumes from entering the turret. Both weapons are mounted in a common block and are elevated by manual controls at the gunner's

station. Both crewmen have identical Raven sights giving magnifications of \times 1 for observation and \times 10 for target engagement. These sights incorporate image intensified night vision giving dual magnifications of \times 2 and \times 6.

Export versions of this turret are available with the 30 mm RARDEN cannon, the stabilised McDonnell Douglas Helicopter 25 mm Chain Gun, or a choice of other 25/30 mm weapons.

Status: Production. In service with the British Army (on Warrior MCV).

Manufacturer: Vickers Defence Systems, Armstrong Works, Scotswood Road, Newcastle-upon-Tyne NE99 1BX, UK.

Telephone: (091) 273 8888 Telex: 53104 Fax: (091) 273 2324

Helio Chieftain No 17 Mark 2 AFV Cupola

Development

This cupola was designed by Helio in conjunction with the Military Vehicles and Engineering Establishment, now the Royal Armament Research and Development Establishment (Chertsey), and is installed on the Chieftain ARVs used by the British, Jordanian and Iranian armies.



Description

The armoured steel cupola body is mounted on a substantial cross roller race and can be continuously rotated through 360° by a manually operated traverse gearbox. The armoured steel hatch cover is fully counterbalanced and can be locked closed, vertical or fully open. An additional feature of the hatch cover is the 'umbrella', or partly open position, which allows the crewman to observe the surrounding terrain while providing a large degree of immunity.

Mounted in the forward part of the cupola is a dual sight with magnifications of \times 10 and \times 1. Another seven periscopes give the crew member almost 360° of vision without rotating the cupola. The dual power sight, which is combined with an image intensification sight for night operations, incorporates an elevating prism which is mechanically linked with the gun mounting to ensure accurate follow between the gun and the sight graticule.

A 7.62 mm GPMG mounted externally on the right side of the cupola can be elevated between –10° and +45° by a hand-operated mechanism. The machine gun is laid, cocked, fired and reloaded from under armour protection.

A searchlight mounted above the boot plate of the cupola moves in elevation and depression with the machine gun. Electrically operated wipers and washers are provided for the external faces of the sight and periscopes.

Status: Production as required. In service with Iran, Jordan and the United Kingdom.

Manufacturer: Helio Mirror Company Limited, Crabtree Manorway South, Belvedere, Kent DA17 6AY, UK.

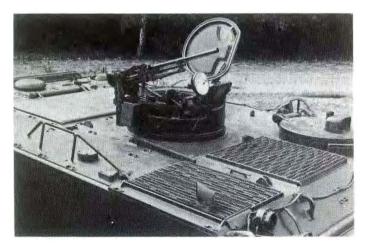
Telephone: (081) 3114140 Telex: 8951666 Fax: (081) 3111004

Helio No 17 Mark 2 AFV cupola with hatch vertical

Helio No 16 and No 26 Lightweight Cupolas

Development

The No 16 and No 26 lightweight cupolas were designed by the then MEL Equipment Company Limited in conjunction with the former Military Vehicles and Engineering Establishment, now the Royal Armament Research and Development Establishment (Chertsey), and production was by Helio in the United Kingdom and the ASCO company in Belgium. The No 16 cupola is standard equipment on the Spartan APC (FV103) and the similar No 26 is installed on the Striker ATGW vehicle (FV102), both of which are members of the CVR(T) Scorpion family of AFVs. It is also suitable for other AFVs and can replace the existing commander's cupola on the M113 APC and, with minor modifications, the commander's cupola on the FV432 APC. The No 16 cupola has also been selected for use on the Alvis Stormer APC.



Description

The cupola is manufactured from armoured steel with a maximum thickness of 16 mm and is mounted on a cross roller race which gives a full 360° traverse. There is a counterbalanced aluminium alloy hatch cover with a minimum thickness of 25 mm which pivots through 170° on the left side of the cupola opposite the machine gun. It is padded to give protection to the commander and can be locked fully open, closed or vertical. When fully closed and locked the cupola is sealed against water entry up to a depth of 4.5 m, and complete protection is given against NBC agents.

A 7.62 mm GPMG, mounted externally on the right side of the cupola, can fire in a vertical arc from -10° to +55° throughout the full 360° of the cupola's rotation. A mechanical or electrical safety interlock, available to suit any vehicle, controls depression at various points throughout rotation to ensure that firing into projections on the vehicle hull is impossible. Traverse and elevation movements are controlled by hand-operated gear systems. The machine gun can be laid, fired and reloaded from inside the cupola with no risk of toxic gases entering the vehicle.

In the forward part of the cupola there is an AFV No 62 periscope, with magnifications of \times 1 and \times 10, which has an elevating top mirror interconnected by a mechanical linkage to both the machine gun and spotlight to ensure that vertical movements of each are accurately followed by the sight graticule. Another eight AFV No 42 periscopes around the rotating ring give the commander a full 360° field-of-view from inside the vehicle without rotating the cupola. There are washers and wipers on the four external faces of all sighting devices. A spotlight, which can be fitted with an infra-red filter, is provided for target illumination.

Status: Production as required. In service with Belgium, Oman and the United Kingdom.

Manufacturer: Helio Mirror Company Limited, Crabtree Manorway South, Belvedere, Kent DA17 6AY, UK.

Telephone: (081) 3114140 Telex: 8951666 Fax: (081) 3111004

Helio No 16 lightweight cupola on M113A1 APC with hatch cover vertical (Ministry of Defence)

SPECIFICATIONS

CREW ARMAMENT AMMUNITION **OPTICS** main

supplementary

1 (aunner) 1 × 7.62 mm GPMG 200 ready-use

> periscope with x 1 and × 10 magnification

WEIGHT (excluding GPMG) 8 periscopes

EXTERNAL DIAMETER

CONTROL

traverse

elevation

360° manual, 1 handwheel turn 9 -10° to +55° manual 1 handwheel turn 4°

346 kg 0.787 m **CUPOLA FLANGE** DIAMETER VEHICLE ROOF **APERTURE**

(above vehicle roof)

HEIGHT

0.76 m

SWEPT RADIUS (GPMG and cupola) 0.819 m

0.546 m

0.819 m

Helio No 27 Lightweight AFV Cupola

Development

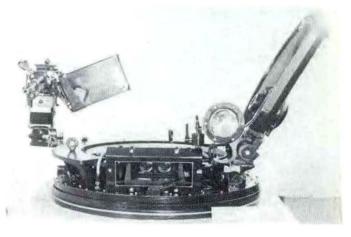
This cupola has been designed by Helio in conjunction with the Military Vehicles and Engineering Establishment, now the Royal Armament Research and Development Establishment (Chertsey), and is standard equipment on the Samson ARV (FV107), Sultan command vehicle (FV105) and the Samaritan ambulance (FV104), and all members of the CVR(T) Scorpion family of tracked vehicles. It is also suitable for other AFVs and can replace the existing commander's cupola on the M113 and, with minor modifications, the commander's cupola on the FV432 series of APC.

Description

The armoured steel cupola body has a minimum wall thickness of 16 mm and, mounted on a cross roller race, can be continuously rotated through 360°. Its low weight and mounting type enable the cupola to be easily rotated by direct manual effort. It can be secured in any position in azimuth by a lock. The aluminium alloy hatch cover is 25 mm thick and is fully counterbalanced and can be locked closed, vertical or fully open. The interior of the hatch cover is fully padded to give protection to the observer. With the hatch cover closed and locked the cupola is sealed against entry to water up to a depth of 4.5 m and affords complete protection against NBC agents

Mounted in the forward part of the cupola is an AFV No 44 Mk 2 periscope enclosed by a hood and a heated window, flanked by five smaller AFV No 42 Mk 1 periscopes, giving the observer 240° of vision without rotating the cupola. For night operations the forward-facing periscope can be replaced by the same type of night periscope used by the driver. The external faces of the periscopes and the heated window have wipers and

A mount on the boot protection plate accepts a standard hand-operated mounting for a 7.62 mm L7A1 No 3 Mk 1 GPMG, which has an elevation of +30° and a depression of -10°. A suitable pintle mount for a 12.7 mm



Helio No 27 lightweight AFV cupola from front with hatch vertical

machine gun is also available. When not in use the machine gun can be locked in a convenient position. A small 100 W spotlight mounted on the boot protector plate can be set and locked in a wide range of positions. If required, the cupola can be delivered with a map light.

Status: In production (several hundred produced to date - 1 January 1993). In service with Belgium, Brunei, Oman, Thailand and the United Kingdom.

Manufacturer: Helio Mirror Company Limited, Crabtree Manorway South, Belvedere, Kent DA17 6AY, UK.

Telephone: (081) 3114140 Telex: 8951666 Fax: (081) 3111004

SPECIFICATIONS

CREW ARMAMENT SIGHTING CONTROL

1 (gunner) 1 x 7 62 mm GPMG 6 periscopes 360° manual traverse WEIGHT excluding GPMG and mount EXTERNAL DIAMETER (rotating ring) VEHICLE ROOF **APERTURE**

123.4 kg

0.825 m 0.76 m

SWEPT RADIUS (gun and cupola) HEIGHT ABOVE ROOF

including GPMG and mount to boot plate

0.537 m 0.165 m

1.143 m

GKN Light Turret

Development/Description

The GKN Light Turret is designed for use on most types of wheeled APCs and the shell and vision blocks offer ballistic protection against ammunition types up to 7.62 mm NATO AP at point blank range.

The high visibility design utilises the standard GKN light turret armoured shell for all weapon fits and can be configured for a number of optional equipments including:

(a) a 5-shot 37 mm riot gun with 20 ready use rounds of smoke, CS riot gas, baton or practice ammunition. A further 100 rounds are stowed in-turret

(b) light machine gun

(c) water cannon

In addition to the main armament option, sets of 66 mm smoke dischargers (eg two groups of four) can be fitted to either side of the turret and on the roof behind the beacon position to give 180° forward spread or directional protection

Other features include a × 1 magnification day or × 5/× 6 magnification day/night sight, a 150 W coaxial spotlight, 150 cu ft/min fume extraction, 100 A and 12 channel slip ring, a 70 W flashing beacon and a customer choice communications fit.



GKN Defence Simba (4 x 4) APC fitted with GKN Defence Light Turret

344 AFV TURRETS AND CUPOLAS / UK

SPECIFICATIONS

CREW ARMAMENT CONTROL

traverse

elevation/depression

OPTICS

OVERALL LENGTH (riot gun fitted)

1 (gunner)

360° +50°/-10°

× 1 magnification day sight or × 5/× 6 magnification day/night sight

1.48 m

HEIGHT ABOVE TURRET RING 0.6 m

(to sight quard)

DEPTH BELOW TURRET RING 1.05 m

Status: Production as required.

Manufacturer: GKN Defence, Hadley Castle Works, PO Box 106, Telford,

Shropshire TF1 4QW, UK.

Telephone: (0952) 244321 Fax: (0952) 243910

Helio FVC 102 Lightweight Cupola

Development/Description

The Helio FVC 102 lightweight cupola was designed to be fitted to light armoured vehicles as an intermediate fit between a full cupola standard and an external mounted pintle machine gun mount.

Access into the cupola area is through an equilibrated hatch. The cupola is ballistically protected against hits by 7.62 mm NATO AP rounds from a distance of 100 m. The hatch when in the vertical position is not immune from the aforementioned attack but can be made so with a weight penalty.

A 7.62 mm MG is mounted externally in a buffered cradle and aimed, cocked and fired from under armour. Gun aiming is effected through a × 1 magnification periscope sight fitted with the appropriate ballistic graticule.

Ammunition is fed to the gun externally via a standard 200-round belt in a box mounted adjacent to the gun mount.

Other machine gun types can be fitted including the McDonnell Douglas Helicopter 7.62 mm Chain Gun for which the necessary electric power will be supplied from the vehicle via a slip ring.

The cupola is rotated by a hand-operated gearbox which is self-locking

by virtue of the internal gear configuration. Gun elevation is effected by another self-locking hand-operated gearbox.

Options include the fitting of a × 6 magnification day sight or day/night

SPECIFICATIONS

CREW 1 (commander) ARMAMENT 1 × 7.62 mm MG AMMUNITION 200 ready-use rounds CONTROL

traverse 360° manual

-10° to +50° manual elevation

WEIGHT (including gun and ammunition) 126 kg

Status: Production as required.

Manufacturer: Helio Mirror Company Limited, Crabtree Manorway South,

Belvedere, Kent DA17 6AY, UK.

Telephone: (081) 3114140 Telex: 8951666 Fax: (081) 3111004

Helio Buffered Mounts for 7.62 mm and 12.7 mm Machine Guns

Development/Description

Helio has developed buffered or soft mounts for a range of 7.62 mm general-purpose machine gun types and the 12.7 mm M2 heavy machine

The gun cradles are buffered to allow controlled lateral movement and reduce the recoil loads. This increases the accuracy and control of the weapons when they are fired in the free condition. The mounts can also be used in a fixed installation such as a coaxial position or in their own right in turrets or cupolas.

In the pintle configuration, for use adjacent to the hatches of AFVs, they are self-contained in as much as they have their own ammunition box carrier and spent case and link collection facility

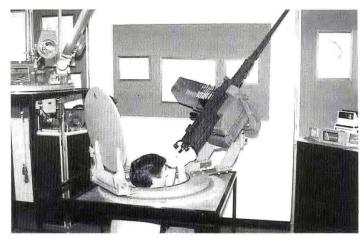
Status: Production (50 plus built to date (1 January 1993) since assembly started in 1989). In service with an unspecified country.

Manufacturer: Helio Mirror Company Limited, Crabtree Manorway South, Belvedere, Kent DA17 6AY, UK.

Telephone: (081) 3114140 Telex: 8951666 Fax: (081) 3111004



Helio soft mount for 7.62 mm GMPG



Helio soft mount for 12.7 mm M2 MG

Helio HMD 848 Lightweight, Fighting Vehicle, Commander's Cupola

This has been designed by Helio for mounting directly on the roof plate of a wide variety of turrets and vehicles, for example, the Cockerill CSE 90 turret installed on the 162 SIBMAS (6 × 6) Armoured Fire Support Vehicles (AFSVs) now in Malaysia.

Description

The cupola is constructed of high hardness steel plate which is immune to 7.62 mm and 5.56 mm armour-piercing and ball rounds at any angle at a 30 m range. The cupola assembly comprises a fixed base unit incorporating six unit power periscopes and an upper rotating platform carrying the hatch cover and mount for a 7.62 mm general-purpose machine gun. The platform can be continuously rotated through 360° in either direction and can be locked in any position in azimuth. The counterbalanced hatch cover can be opened through 135° for easy access and can be locked in the fully open, intermediate 95° and closed positions.

SPECIFICATIONS

DIAMETER
outside of fixed base unit
outside of rotating platform
hatch opening
hole in turret roof plate
PCD OF MOUNTING
BOLTS
O.714 m
MAX OVERALL HEIGHT

FROM TURRET ROOF
PLATE 0.204 m

MAX SWEPT RADIUS AT ROTATING PLATFORM (without MG)

 (without MG)
 0.425 m

 TRAVERSE
 manual

 PERISCOPES
 6 unit power

 SEALING
 with hatch or

with hatch cover closed cupola is sealed against ingress of water up to a depth of 4 to 5 m and gives protection against NBC agents

WEIGHT (excluding MG and mounting) 121 kg

Status: In production (100 plus produced to date - 1 January 1993). In service with Malaysia.

Manufacturer: Helio Mirror Company Limited, Crabtree Manorway South, Belvedere, Kent DA17 6AY, UK.

Telephone: (081) 3114140 Telex: 8951666 Fax: (081) 3111004

HMD 848 Lightweight, Fighting Vehicle, Commander's Cupola on CSE 90 turret on SIBMAS (6×6) Armoured Fire Support Vehicle for Malaysian Army



Helio FVH 300 High Angle 7.62 mm or 12.7 mm Machine Gun Hatch

Development/Description

The FVH 300 has been designed as a natural development of the FVM 200 machine gun mounting. All parts are interchangeable and one can be converted to the other very rapidly.

The FVH 300 is equipped with a unit power day vision periscope for forward observation and a high-angle mounting for the 7.62 mm general-purpose machine gun. The main body carrying the hatch cover, periscope and weapon mounting is attached to a bearing allowing effortless rotation in either direction through 360° and lockable in six positions. The hatch cover, which is fully counterbalanced for ease of operation, can be locked in the fully vertical position, so protecting the gunner from rear attack.



FVH 300 high angle machine gun hatch fitted with 7.62 mm GPMG on Alvis Stormer APC

The main body and hatch cover are manufactured from high hardness plate which gives immunity against 5.56 mm and 7.62 mm armour-piercing rounds at any angle of attack at a 30 m range. Protective padding is fitted to the inner ring and hatch.

The FVH 300 will accept a variety of 7.62 mm as well as 5.56 mm machine guns. Other small calibre machine guns will be considered. A suitable pintle mount for the 12.7 mm machine gun is also available.

SPECIFICATIONS

meter equally spaced on 725 mm PCD

ELEVATION -15° to +90°

IMMUNITY 7.62 mm and 5.56 mm AP from any angle of attack at 30 m

WEIGHT 98 kg

Status: Production (200 plus produced to date - 1 January 1993).

Manufacturer: Helio Mirror Company Limited, Crabtree Manorway South,

Belvedere, Kent DA17 6AY, UK.

Telephone: (081) 3114140 Telex: 8951666 Fax: (081) 3111004

Helio FVM 200 High Angle 7.62 mm Machine Gun Mounting for Trucks

Development/Description

The FVM 200 has been designed and developed by Helio as a straight forward mounting for 7.62 mm machine guns on trucks, enabling the user to engage targets in any position in azimuth and from ground attack to directly overhead in elevation.

The machine gun mounting is attached to a fully rotating (360°) bearing attached to the roof of the cab. The user can adopt a comfortable upward

stance while operating at any angle of elevation or depression. Continuous rotation through 360° in azimuth is achieved via a preloaded wire bearing. On the forward part of the mounting is a rack for a box of 200 rounds of ready-use 7.62 mm ammunition. For improved accuracy in the air defence role the manufacturer suggests that the machine gun is fitted with Helio LLAD No 100 sight. The mount will accept a variety of 7.62 mm machine guns as well as 5.56 mm weapons, and other small calibre machine guns will be considered by the manufacturer. The machine gun mount can be trippod-mounted for use from a ground position or can be used in conjunction with a fixed bracket system for installation in open vehicles such as Jeeps.

Helio FVM 200 High Angle 7.62 mm Machine Gun Mounting for Trucks fitted with 7.62 mm GPMG with LLAD No 100 sight

SPECIFICATIONS

MAX HEIGHT (base ring to top of mounting) MAX SWEPT RADIUS DIAMETER outside of base ring

ELEVATION

WEIGHT

 $0.75 \, \text{m}$ inside of base ring 0.585 m -15° to +90° 44 ka

Status: Production (150 plus produced to date - 1 January 1993).

Manufacturer: Helio Mirror Company Limited, Crabtree Manorway South,

0.216 m

0.692 m

Belvedere, Kent DA17 6AY, UK. Telephone: (081) 3114140 Telex: 8951666 Fax: (081) 3111004

UNITED STATES OF AMERICA

TCM 105 mm Low-Profile Turret (LPT)

The Teledyne Continental Motors (TCM) Low-Profile Turret (LPT) and autoloader concept was validated during the mid-1980s as part of the US Army requirement for an Armored Gun System (AGS). The AGS demonstrated the solution for main gun performance integrated to a lightweight transportable vehicle system.

The LPT has been operated on a Centurion Mk 5, and an installation kit has been designed for the M60. The LPT has also been applied to the US Marine Corps Light Armored Vehicle (LAV) in the LAV-105 study.

TCM has also developed complete modernisation packages for the M-series MBTs, T-54/55/62 series MBTs, the AMX-30 and the Centurion. Included amongst the improvements can be the fitting of the LPT.

The main features of the turret are:

- (1) increased survivability by:
 - (a) reducing tank profile and making it harder to hit
 - (b) reducing combat weight so that savings can be re-applied as additional armour
 - (c) reducing crew size
 - (d) relocating the crew and ammunition into tank hull so as to increase protection factor
- (2) logistics:
 - (a) allows for armament lethality growth
 - (b) is of modular design for equipment upgrading/replacement
 - (c) is adaptable to a range of combat vehicles
- (3) lethality
 - (a) uses the M60A3 as baseline
 - (b) is expandable as new technology is fielded.

Description

The LPT incorporates an external overhead gun and autoloader into a twoman turret with a 1.85 m turret ring. This design feature allows the turret to be much smaller and lighter with the commander and gunner enclosed within the vehicle hull envelope.

The design is a flat welded steel pod and turret with the commander and gunner sitting side-by-side low in the hull. The autoloaded external gun turns with the turret (the crew is in an aluminium basket with spall liners) through a full 360° of traverse. The main control panel is accessible by either crew member and, since both have control handles and sights, complete turret operation (target acquisition, aiming and firing) may be performed by either. The fire control system is fully stabilised and supported by a digital ballistic computer. One version, the Bradley M2/M3 IFV electric turret drive with manual backup, is used to control the gun position and to remove the hazards of flammable hydraulic fluid from the crew compartment.

The gunner utilises a thermal sight with an image provided to the commander through a video link. During emergency situations the optical auxiliary sight is available to both crew members. Closed hatch 360° unity visibility is provided by the use of periscopes with overlapping fieldsof-view. The commander alone has 330° of unobstructed vision.

The NATO standard 105 mm M68A1 main gun fitted has a 706 mm recoil mechanism and muzzle brake to minimise the gun recoil impulse. Growth features in the turret can accommodate an increase in gun calibre to 120 mm.

The baseline lethality of the LPT in terms of firepower and accuracy is taken as the M60A3. Studies show that this can be increased to M1A1 Abrams levels which extends the lethality to 3500 m. On smaller vehicles the turret contains nine ready rounds in the revolver type magazine while larger platforms may utilise a six-pack option resulting in 15 ready rounds. The revolver may be automatically or manually replenished depending upon the vehicle type and level of sophistication required. The gun has full KE ammunition capability and will fire all versions of the 105 mm tank gun ammunition family.

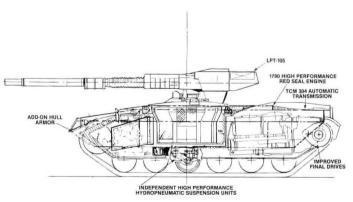
The maximum rate of fire is 10 rds/min with the autoloader automatically locating the designated round, loading and downloading if required. Misfires, spent cartridges, smoke and noxious fumes are all ejected overboard to the rear of the vehicle.

A 7.62 mm M240 machine gun is mounted coaxial with the thermally shrouded M68 gun. The commander's weapon is optional with a choice of the 7.62 mm M240, 7.62 mm M60D or the 12.7 mm MG HB machine gun or a 40 mm automatic grenade launcher. In addition, TOW and Hellfire ATGW options may also be added to the gun pad to make the LPT into a longrange tank destroyer.

The LPT reduces the vehicle weight on the T-54 MBT by 2200 kg and on a Centurion MBT by 5000 kg. These immediate weight savings and resultant increase in vehicle mobility can be exchanged for added protection by applying additional hull armour. Then, depending upon the desired vehicle mobility, either conventional inexpensive RHA steel plate or more costly composite armour can be chosen.



Modified Centurion MBT chassis fitted with Low Profile Turret armed with 105 mm M68 rifled tank gun



Outline of M60 MBT fitted with Low-Profile Turret and modernised in a number of other key areas

SPECIFICATIONS Turret Model	Light	Hanne
	9	Heavy
MAX DIAMETER	2.082 m	2.286 m
BARE WEIGHT	3909 kg	5806 kg
MAIN BEARING DIAMETER	1.854 m	1.93 m
BASKET DIAMETER	1.593 m	1.696 m
MAX SLEW RATE	40°/s	35°/s
CREW	2 (commander, gunner)	
ARMAMENT		
main	1 × 105 mm M68A1 gun	

1 × 7.62 mm M240 MG coaxial commander (optional) 1 × 7.62 mm M60D or M240 MG or 1×12.7 mm M2 HB heavy MG or 1×40 mm

automatic grenade launcher

MAX RECOIL 787.4 mm 3200 lb-s

IMPULSE AMMUNITION

autoloader main gun

9-round revolver magazine

coaxial MG 1000 rounds Turret Model TURRET/GUN DRIVE FIRE CONTROL OPTICS Primary

Light Heavy electric Bradley IFV derivative digital system

Texas Instruments CITV lightweight modular (x 8 magnification) day, 2 FOV, FLIR, trunnion encoder, laser rangefinder, video link

to commander

optional, mounted on gun pod

Auxiliary commander and 7 x mechanically driven auxiliary

gunner sights with two eyepieces

Status: Prototype.

Panoramic

Manufacturer: Teledyne Continental Motors, General Products, 76 Getty

Street, Muskegon, Michigan 49442, USA.

Telephone: (616) 724 2151 Fax: (616) 724 2928

Cadillac Gage Textron LAV-105 mm Weapon System

Development

Cadillac Gage Textron was awarded a 40 month TACOM contract to design, build and integrate three lightweight 105 mm gun turrets into the US Marine Corps Light Armored Vehicle (LAV). The contract period included 20 months for design and fabrication of the prototypes and 20 months for trials. Late in 1991, however, the US Marine Corps cancelled the whole LAV-105 project as there were no production funds available between 1993 and 1996.

Early in 1993 indications were that efforts were being made to restart this programme as, within the 1117 LAV (8 × 8) vehicles being built in Canada for the Saudi Arabian National Guard, there was a quantity of Assault Gun vehicles that would have utilised the LAV-105 two-man turret.

The two-man lightweight turret is to be made from all-welded steel. The commander and gunner each have a single-piece hatch cover that opens to the rear and four periscopes to view to the rear and sides. The gunner has a stabilised thermal day/night sight with integral laser rangefinder whilst the commander has a Hughes stabilised thermal day/night remote monitor unit.

The main armament is a Benet Lab 105 mm EX-35 low recoil rifled tank gun which fires standard NATO 105 mm ammunition. The gun is fed from a Fairey Hydraulics bustle-mounted electromechanical automatic loading system containing eight ready use rounds



Cadillac Gage Textron LAV-105 mm Weapon System installed on LAV (8 × 8) chassis

A 7.62 mm M240 machine gun is fitted as the coaxial armament. On the AGS turret variant the commander also has an external pedestal mounted 7.62 mm or 12.7 mm machine gun for anti-aircraft and local defence use. Either side of the turret, firing forwards, are two banks of four electrically operated M257 smoke dischargers.

Turret traverse and weapon elevation is electromechanical with the traverse being a full 360° and depression/elevation from -8° to +15°. The gunner or commander can either traverse or elevate the armament. Manual backups are installed in case of a primary weapon control system failure.

Weapon firing is electrical with manual backup. The armament is stabilised in two axes by a Cadillac Gage Textron Systems Division weapon system that is currently under development.

The fire control system is based on a Computing Devices Company (CDC) digital fire control computer that is derived from those used in the M1 Abrams and Challenger 2 programmes. This uses Ada/Pascal code and inputs/outputs to and from the laser rangefinder, autoloader controller, gun turret drive, various sensors, line-of-sight electronic units, built-in test devices and the ergonomic MMI Flat Panel Display.

SPECIFICATIONS

WEIGHTS (loaded)

CREW	2 (commander and gunner)
ARMAMENT	
main	1 × 105 mm EX-35 gun
coaxial	1 × 7.62 mm M240 MG
anti-aircraft	1×7.62 or 12.7 mm MG
smoke dischargers	2 × 4 M257
AMMUNITION	

105 mm 400 coaxial anti-aircraft 100 CONTROL

360°, electromechanical with traverse manual backup

tracking rate 0.25 mils/s depression/elevation -8°/+15°, electromechanical with

manual backup elevation rate 100 mils/s **OPTICS**

commander 4 × periscopes, 1 × thermal day/ night remote monitor

4 × periscopes, 1 × thermal day/ night sight

3696 kg

Status: Development stopped in 1991 but may be resumed in future (see

Manufacturer: Cadillac Gage Textron, PO Box 1027, Warren, Michigan

Telephone: (313) 777 7100 Telex: 200707 CGAGE UR Fax: (313) 776

Cadillac Gage Textron 105 mm Low Recoil Force Turret

Development

In late 1983 the British Royal Ordnance and Cadillac Gage Textron of the USA announced a joint agreement to develop an advanced turret system armed with a 105 mm low recoil gun suitable for installation on a wide range of tracked and wheeled armoured vehicles such as the V-600 Commando (6 × 6), M551, M41, M47 and T-54/T-55 series.

The first prototype of the 105 mm Low Recoil Force Turret was completed in mid-1984 and installed for trials on an M551 light tank chassis. The trials began in June 1984 at Camp Perry, Ohio, and included the firing of proof rounds from various turret positions, including 90° to the hull centre line.

The 105 mm Low Recoil Force Turret is installed on the Cadillac Gage Stingray light tank and has also been installed on an M41 light tank chassis and the V-600 (6 × 6) armoured car (previously known as the V-300A1) for

Description

The turret is of all-welded Cadloy steel armour which provides complete protection over its frontal arc against 14.5 mm projectiles, and against 7.62 mm projectiles over the remainder.

The loader sits on the left of the turret and has a single-piece hatch cover that opens to the rear. The commander sits on the right of the turret with the gunner forward and below his position. The commander has a rear-opening, single-piece hatch cover, seven periscopes for all-round observation and an NV52C day/night sight. The gunner has an M36E1 SIRE day/night sight, the loader a single forward-facing periscope.

Main armament consists of a Royal Ordnance Nottingham 105 mm Low Recoil Force Gun which is fully described in the *AFV Armament* section. The gun is essentially the combat-proven L7A3 with a new recoil system and muzzle brake which can still fire all standard NATO ammunition. It has eight rounds of ready-use ammunition stowed below the turret ring. A 7.62 mm machine gun is mounted coaxially to the left of the main armament with 400 rounds of ready ammunition, and a 7.62 mm or 12.7 mm machine gun with 100 rounds of ready-use ammunition can be mounted on the turret roof for anti-aircraft defence. There are four electrically operated smoke dischargers on either side of the turret. A 500 000 candlepower searchlight moves in elevation with the main armament.

Turret traverse and gun elevation are electrohydraulic with manual controls for emergency use. As an option a full two-axis stabilisation system can be fitted. The commander's sight is electrically linked to that of the gunner and the commander has the capability to override the gunner.

The prototype turret is fitted with an optional Marconi Radar and Control Systems Digital Fire Control System with an Optic Electronic Corporation gunner's sight with day/night vision, laser rangefinder and moving graticule. This system allows the gunner to engage the target in under 10 seconds from identification and to fire the second round within seven seconds.

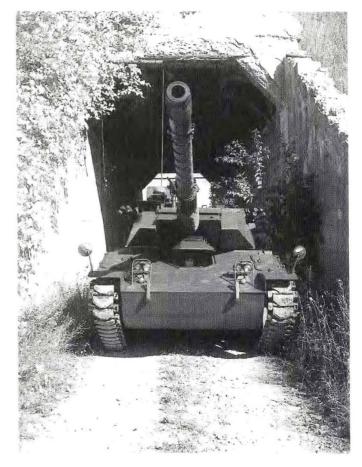
The hydraulic powerpack and radios are in the turret bustle. The turret can be fitted with an NBC system of the ventilated mask collective type and there is potential for a hybrid or overpressure system in certain vehicles.

Status: Production as required. In service with Thailand (on Cadillac Gage Textron Stingray light tanks).

Manufacturer: Cadillac Gage Textron, PO Box 1027, Warren, Michigan

Telephone: (313) 777 7100 Telex: 200707 CGAGE UR

Fax: (313) 776 9731



Cadillac Gage Textron Stingray light tank fitted with 105 mm Cadillac Gage Textron Low Recoil Force Turret

SPECIFICATIONS		SIGHTING		POWER SUPPLY	24 V DC
CREW	3 (commander,	commander	1 × NV52C sight	TURRET RING	
	gunner, loader)		7 periscopes	DIAMETER	1.83 m
ARMAMENT		gunner	1 × M36E1 SIRE sight	LENGTH	7.518 m
main	1 × 105 mm gun	SUPPLEMENTARY VISION		WIDTH	2.438 m
coaxial	1 × 7.62 mm MG	commander	7 periscopes	HEIGHT ABOVE TURRET	
anti-aircraft	1 × 7.62 mm or	loader	1 periscope	RING	0.749 m
	12.7 mm MG	GUN CONTROL EQUIPMENT	,	DEPTH BELOW TURRET	
SMOKE DISCHARGERS	2 × 4	turret power control	electrohydraulic/manual	RING	0.914 m
AMMUNITION (ready-use)		by commander	yes	ARMOUR PROTECTION	against 14.5 mm over
105 mm	8	by gunner	yes		front
7.62 mm	400	traverse	360° at 30°/s		against 7.62 mm over
anti-aircraft	100 × 12.7 mm or	elevation	-7.5° to +20° at 40°/s		remainder
	200 × 7.62 mm	WEIGHT (without crew)	4740 kg		

Cadillac Gage Textron 90 mm Turret

Development/Description

The 90 mm turret was originally designed by Cadillac Gage Textron for its V-150 Commando vehicle, but is now being offered for other AFVs such as the M113A1 APC. It is a two-man turret fitted with a 90 mm Cockerill Mk III gun, a coaxial 7.62 mm machine gun and a commander's ring mount with a pintle-mounted 7.62 mm machine gun.

The turret can be rotated 360° under power at speeds of up to 30° /s and the 90 mm gun can be elevated from -7 to $+28^\circ$ at speeds of up to 30° /s. Dual controls allow either the gunner or commander/loader to operate the turret and fire the main armament. Emergency mechanical hand-operated controls which can be used if the electrohydraulic controls are disabled are scaled-down versions of the Cadillac Cage controls in all production M60 and Leopard 1 MBTs. The turret is fitted with interior lighting and an extractor fan.

The turret has external vision by means of three direct view blocks, a commander's periscope mounted in the machine gun ring mount that provides 360° rotation and a gunner's periscope with a \times 8 monocular and a



× 1 periscope with a projectile graticule. For night surveillance a 200 mm, 500 000 candlepower white light spotlight is mounted coaxially with the 90 mm gun. The turret armour will defeat 7.62 mm AP projectiles at 0° obliquity and point blank range. Front turret armour is capable of defeating 14.5 mm projectiles fired from a range of 500 m. The turret is provided with a stowage basket at the rear and smoke/fragmentation dischargers can be fitted if required

Status: Production as required. In service with many undisclosed countries. By early 1993 over 280 of these turrets had been completed.

Manufacturer: Cadillac Gage Textron, Post Office Box 1027, Warren,

Michigan 48090, USA.

Telephone: (313) 777 7100 Telex: 200707 CGAGE UR Fax: (313) 776 9731

SPECIFICATIONS CREW

ARMAMENT

main coaxial anti-aircraft 2 (gunner and commander/loader)

 $1 \times 90 \text{ mm gun}$ 1 × 7.62 mm MG 1 × 7.62 mm MG

AMMUNITION main coaxial anti-aircraft

CONTROL traverse elevation

8 ready-use in turret 400 ready-use in turret 200 ready-use in turret

360° electrohydraulic -7° to +28° electrohydraulic at 30°/s

OPTICS

commander

3 vision blocks periscope 360° traverse

× 8 monocular and gunner

× 1 periscope with projected graticule

WEIGHT (less crew) 2086 kg POWER SUPPLY 24 V

AV Technology Corporation Two-Man 90 mm Turret

Development/Description

The AV Technology 1.506 m ring diameter two-man 90 mm turret has been mounted on a number of armoured vehicle types including the LFV-90 mm (two man turret) variant of the Dragoon Light Forces (4 × 4) Vehicle.

The turret is constructed from welded steel plate armour that provides the same degree of protection as the hull and is equipped with mounts for a 90 mm light assault cannon (for example a Cockerill 90 mm Mk III or MECAR 90 mm KEnerga) and a coaxial 7.62 mm or 12.7 mm machine gun. A further 7.62 mm machine gun can be mounted on a pintle mount for antiaircraft use. Two four-round smoke grenade launchers are fitted either side of the cannon mantlet firing over the frontal arc of the vehicle.

Weapons firing is performed by an electrical system with a secondary emergency manual backup facility available. An electrical firing interruptor unit is also fitted.

The turret control system is electrohydraulic and operated by a single handgrip controller in azimuth and elevation. Manual secondary controls are fitted as emergency backup units for both elevation and azimuth

Ready-use ammunition stowage space is provided for 10 rounds of 90 mm, 600 rounds of 7.62 mm and the eight smoke grenades in their launchers. Space is also allocated in the turret bustle for a wide variety of radio communications fits.

For observation purposes the gunner has a modified M36E1 passive day/night sight whilst the commander has seven M27 periscopes for allround vision. Other types of gunner's sight assembly (including thermal imaging) are available.

The turret is fitted with solid-state electronics and autodeck interrupt whilst NBC protection, together with a commander's control and override facility, are optional items.



Dragoon Light Forces Vehicle fitted with AV Technology two-man 90 mm turret armed with MECAR 90 mm KEnerga cannon

Status: Production as required.

Manufacturer: AV Technology Corporation, 50405 Patricia Drive, Mount

Clemens, Michigan 48045, USA

Telephone: (313) 949 8808 Fax: (313) 949 8760

SPECIFICATIONS

WEIGHT ARMAMENT

CREW

main coaxial

anti-aircraft (optional) smoke dischargers AMMUNITION (ready-use)

90 mm 7.62 m smoke grenades two (commander and gunner)

1951 kg

1 × 90 mm cannon

1 × 7.62 mm or 12.7 mm MG

1 × 7.62 mm MG

 2×4 tube

10 600 8

CONTROLS elevation/depression

traverse

max traverse rate **OPTICS**

commander gunner

TURRET RING DIAMETER POWER SUPPLY

-8° to +45°, electrohydraulic with

manual backup

360°, electrohydraulic with

manual backup 36°/s

 $7 \times M27$ periscopes

1 × modified M36E1 sight

1.506 m 24 V

Cadillac Gage Textron 76 mm Turret

Development/Description

The 76 mm turret was originally designed by Cadillac Gage Textron for its V-150 Commando vehicle, but it is now being offered for installation in other AFVs such as the M113A1 APC. It is a two-man turret fitted with a British 76 mm L23A1 gun (as installed in the Alvis Scorpion), a coaxial 7.62 mm machine gun and a commander's ring mount with a pintle-mounted 7.62 mm machine gun.

The turret can be rotated through 360° under power at up to 45°/s and the 76 mm gun can be elevated from -10 to +30° under power at up to 45°/s. Dual controls allow either the gunner or commander/loader to operate the turret and fire the main armament. Emergency mechanical hand-operated controls,

which can be used if the electrohydraulic controls are disabled, are scaleddown versions of the Cadillac Gage Textron controls on all production M60 series and Leopard 1 MBTs. The turret is fitted with interior lighting and an extractor fan.

The turret has external vision by means of three direct view blocks, a commander's periscope mounted in the machine gun ring mount that provides 360° rotation and a gunner's periscope with a × 8 monocular and a x 1 periscope with a projected graticule. For night surveillance a 200 mm. 500 000 candlepower white spotlight is mounted coaxially with the 90 mm gun. The turret armour will defeat 7.62 mm AP projectiles at 0° obliquity and point blank range. Front turret armour is capable of defeating 14.5 mm projectiles fired from a range of 500 m. The turret can be fitted with a stowage basket at the rear and smoke/fragmentation dischargers can be mounted externally on either side of the turret if required

Status: Development complete. Production as required.

Manufacturer: Cadillac Gage Textron, Post Office Box 1027, Warren,

Michigan 48090, USA.

Telephone: (313) 777 7100 Telex: 200707 CGAGE U

Fax: (313) 776 9731

Telex: 200707 CGAGE U



Cadillac Gage Textron 76 mm turret on Cadillac Gage Textron V-150 Commando (4×4) vehicle

	SPEC	IFICA'	TIONS
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CREW

ARMAMENT

coaxial anti-aircraft 2 (gunner and commander/loader)

1 × 76 mm gun 1 × 7.62 mm MG

1 × 7.62 mm MG

AMMUNITION

main coaxial anti-aircraft CONTROL

traverse elevation 10 ready-use in turret comm

600 ready-use in turret 200 ready-use in turret

360° electrohydraulic at 45°/s

-10° to +30° electrohydraulic at 30°/s OPTICS

commander

gunner

WEIGHT (less crew) POWER SUPPLY 3 vision blocks 360° traverse periscope × 8 monocular and

× 1 periscope with projected graticule

1656 kg 24 V

Cadillac Gage Textron 40 mm/12.7 mm Upgunned Weapons Station (UWS)

Development/Description

This one-man turret, a further development of the Cadillac Gage Textron twin/combination machine gun (1 m) turret, is armed with a 40 mm Mk 19 grenade launcher on the left and 12.7 mm (0.50) M2 HB machine gun on the right. Cadillac Gage Textron made an unsolicited proposal to the US Marine Corps to install this turret on a standard FMC AAV7 armoured amphibious assault vehicle for trials. The turret was armed with the 40 mm Mk 19 Mod 1 grenade launcher and the 12.7 mm M2 HB machine gun. For Development Test/Operational Test I at Camp Pendleton the Mod 1 grenade launcher was replaced by the more recent Mod 3. These trials were such a success that the Marine Corps placed an order with the company for three production turrets for DT/OT II and these were delivered in mid-1983. Early in 1986 and after a competitive procurement the US Naval Sea Systems Command, acting for the US Marine Corps, placed an order with Cadillac Gage Textron for the supply of 240 Upgunned Weapons Stations. First production turrets were delivered in early 1987. Total value of this contract was \$17.236 million. The US Marine Corps also took an option for an additional 100 turrets. This was exercised in January 1987 at a cost of \$5.823 million. Late in 1987 Optic Electronic Corporation of Dallas, Texas, was awarded a contract by Cadillac Gage to supply a modified M36E1 day/

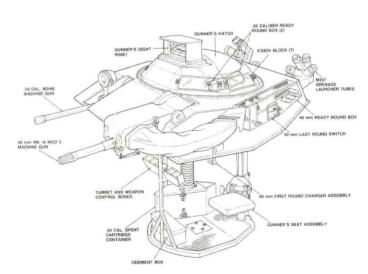
night/laser rangefinder sight for this turret.
In September 1988 AV Technology Corporation was awarded a competitive re-buy contract for UWS turrets.

The turret is of Cadloy ballistic steel armour, the gunner having an M36E1 periscopic sight with a magnification of \times 1 and \times 7, seven vision blocks and a single-piece hatch cover opening to the rear.

A 500 000 candlepower spotlight is mounted above the 12.7 mm M2 machine gun and moves in elevation with the weapons. A bank of four 76 mm electrically operated smoke dischargers is mounted either side of the turret rear.

Status: Production as required. In service with US Marine Corps.

40MM / .50 CALIBER TURRET



Detailed drawing of Cadillac Gage Textron 40 mm/12.7 mm Upgunned Weapons Station showing position of weapons and ammunition boxes (not to 1/76th scale)

Manufacturers: Cadillac Gage Textron, Post Office Box 1027, Warren,

Michigan 48090, USA

Telephone: (313) 777 7100. Telex: 200707 CGAGE UR

Fax: (313) 776 9731

SPECIFICATIONS CONTROL WIDTH 1.37 m LENGTH CREW 360°, electric (45°/s) 1 (gunner) traverse ARMAMENT 1 × 40 mm grenade with manual fine lay (without armament) 2.1 m WEIGHT (combat loaded) launcher elevation -8° to +45° 1 × 12.7 mm MG manual (10°/s) without armament 936 kg 1068 kg AMMUNITION **OPTICS** M36E1 (mod) sight with armament 40 mm 100 ready-use 7-vision blocks POWER SUPPLY 24 V 12.7 mm 200 ready-use HEIGHT (OA) 1.9 m

FMC 40 mm/12.7 mm Enclosed Weapon Station

Development/Description

The 40 mm/12.7 mm Enclosed Weapon Station was developed by the FMC Corporation as a drop-in replacement for the FMC one-man 12.7 mm machine gun turret originally installed on US Marine Corps AAV7A1 amphibious vehicles, but early in 1986 the Marine Corps selected the competing Cadillac Gage Textron turret (see previous entry). This turret has also been tested on an M113A3.

The upper structure of the Enclosed Weapon Station mounts both weapons in a single rotor so permitting opening of all AAV7A1 engine access hatches without removing the weapon station or weapon station parts.

The turret basket is identical to the standard AAV7A1 weapon station. Other common parts include searchlight, fume evacuation fan, bearing ring, bearing ring seal, electrical instruments, seat, slip ring and intercom. The existing deck clearance device is modified.

The 40 mm Mk 19 Mod 3 grenade launcher is mounted on the left with the 12.7 mm M2 HB machine gun on the right. The gunner has a rearopening single-piece hatch cover, eight periscopes for all-round observation, one indirect optical sight with a magnification of x7, x7 image intensifier, and one unity sight.

Status: Ready for production.



M113A3 with FMC 40 mm/12.7 mm Enclosed Weapon Station

Manufacturer: FMC Corporation, Ground Systems Division, 881 Martin Avenue, PO Box 58123, Santa Clara, CA 95052, USA Telephone: (408) 298 2882 Telex: 910 338 0045

SPECIFICATIONS CREW	1 (gunner)	CONTROL traverse	360°, manual with	WEIGHT (less gunner) RING PITCH GEAR	900 kg
ARMAMENT	1 × 12.7 mm MG		power assist at max	DIAMETER	0.869 m
	1 × 40 mm grenade		of 45°/s	HEIGHT	
	launcher	elevation	-8° to +45°	overall	1.93 m
AMMUNITION		OPTICS	9 vision blocks	above deck	0.94 m
12.7 mm ready-use	200		sight with \times 1	BASKET DEPTH	0.99 m
40 mm ready-use	120		magnification sight	POWER SUPPLY	24 V
			with × 7		

AV Technology Corporation One Man Armament

Development/Description

The AV Technology 1 m ring diameter One Man Armament Turret has been mounted on a number of armoured vehicle types including the LFV-40 mm (one-man turret) variant of the Dragoon Light Forces (4 × 4) Vehicle.

The turret is of all-welded steel construction and provides the same degree of protection as the Dragoon vehicle on which it is mounted. The gunner has a one piece hatch cover that opens to the rear.

The turret is equipped with mounts for a Mk 19 Model 3 40 mm automatic grenade launcher and a coaxially mounted 12.7 mm (0.5 in) M2 HB heavy machine gun with associated 500 000 candle power spotlight. There are also two four-round smoke grenade launcher tube units attached to either side of the turret rear firing over the frontal arc of the vehicle. Other weapons can also be fitted if required.

The Mk 19 40 mm automatic grenade launcher has a maximum range in excess of 2200 m and can fire the M430 High Explosive Dual Purpose (HEDP) round. This can penetrate 50 mm of conventional armour at over 2000 m range so enabling successful engagement of most types of light armoured vehicles.

The 12.7 mm M2 HB can engage targets out to an effective range of 2000 m and uses the full range of 12.7 mm ammunition available including a newly available exploding round type. Future ammunition developments will also enable the weapon to engage armoured infantry carriers in extended range situations.

Weapon firing is by an electrical system with a manual backup facility and an electrical fire interruptor is also fitted.

A total of 100 rounds of 40 mm, 200 rounds of 12.7 mm and eight L8A1 smoke rounds are carried for ready-use by the turret weapons.

For observation purposes the operator has a modified M36E1 gunner's passive day/night sight and seven unity vision blocks, each with a black-out capability. Other sight types (including thermal imaging) are available

Space is allocated in the turret to allow the fitting of any one of a variety of radio communications systems. It is also equipped with solid state electronics whilst NBC protection, together with a commander's control and override facility, are optional items

SPECIFICATIONS

CREW WEIGHT ARMAMENT

1227 kg

1 × 40 mm Mk 19 Mod 3 automatic main grenade launcher

1 x 12.7 mm M2 HB machine gun coaxial smoke dischargers 2×4 tube

12.7 mm smoke grenades CONTROLS

40 mm

with × 7 image intensifier

elevation/depression

traverse max traverse rate **OPTICS**

RING DIAMETER POWER SUPPLY

AMMUNITION (ready-use)

100 200

-8° to +45°, manual

360°, manual fine lay with electric assist

45°/s

1 × modified M36E1 sight, 7 × unity vision blocks

24 V DC

Status: Production as required

Manufacturer: AV Technology Corporation, 50405 Patricia Drive, Mount

Clemens, Michigan 48045, USA

Telephone: (313) 949 8808 Fax: (313) 949 8760



Dragoon Light Forces Vehicle fitted with AV Technology Corporation One-Man Armament Turret armed with 40 mm grenade launcher and 12.7 mm machine gun

General Electric Blazer Air Defence Turrets

Development

The modular Blazer Air Defence Turret was originally developed as a private venture project. The basic configuration comprises a two-man power operated turret with a 25 mm GAU-12/A Gatling Gun and two four-round pods of Stinger fire-and-forget surface-to-air missiles.

A fire-on-the-move capability is provided by a stabilised FLIR/TV passive acquisition/automatic tracking sight coupled to a digital full solution fire-control system. A Thomson TRS 2620 Gerfaut radar option can provide automatic target acquisition out to 14 000 m.

The basic configuration (without the radar option) was offered in a competitive contest to meet the US Marine Corps requirement for an air defence turret to be mounted on its Light Armored Vehicle - Air Defense (LAV-AD) variant. In June 1992 GE were awarded the contract.

Apart from the LAV-AD, the turret is suitable for installation on a number of other vehicles. These include the MOWAG Piranha (8 \times 8) Alvis Stormer, M113, Cadillac Gage Textron V-300 (6 \times 6) and Cadillac Gage V-150 S (4 \times 4).

Instead of the 4-round Stinger missile pods, two 3-round Matra Mistral surface-to-air missile pods can be fitted. As a further option a 7-round pack of HYDRA 70 unguided can also be fitted.

Description (Basic Blazer Turret)

The Blazer turret is power operated and of all welded construction with light armour. It can be mounted on any tracked or wheeled armoured vehicle that can accommodate a turret ring of 1.625 m diameter. The two-man turret houses both gunner and commander, each capable of full system operation including target acquisition, target tracking, weapon selection and firing. Vision is through armoured windows on the turret front and sides. Digital servo drives allow accurate weapon stabilisation and positioning.

Main armament comprises the 25 mm GAU-12/A gun which fires the Bushmaster family of ammunition at 1800 rds/min. Effective range is up to 2500 m. This is complemented by two packs of four Stinger or two packs of three Mistral passive infra-red homing missiles mounted above the gun cradle and integrated into the fire-control system. The missiles can engage targets out to 6000 m. Immediately above the gun itself can be mounted the HYDRA unguided rocket pack.

Sensors comprise the FLIR/TV sight for viewing and autotracking and an eye-safe laser rangefinder. If the radar option is exercised the Thomson-CSF Gerfaut adds IFF, automatic track-while-scan and data exchange for netting capabilities. The latter allows one Blazer system to act as a command and control centre for several other Blazer vehicles without any need for them to operate their active acquisition sensors. The commander monitors the acquisition radar whilst the gunner performs the engagement sequence.



Blazer Heavy Turret on FMC Bradley Fighting Vehicle chassis



GE Blazer equipped Light Armored Vehicle/Air Defense as ordered for the US Marine Corps

Variant

Blazer Heavy Turret

The Blazer Heavy Turret is 90 per cent common to the Blazer turret configuration chosen for the LAV-AD and is designed to meet the perceived Foreward Air defence requirements of the US Army. It is fully compatible with the Bradley Fighting Vehicle and features an armour upgrade of the existing turret structure and minor modifications to the turret bearing and basket. It will accept a variety of sensors including radar, Infra-Red Search and Track (IRST) and others. The Texas Instruments Blazer sight can be modified to provide designation for alternative weapons in addition to its ranging function. This will allow the Blazer Heavy to counter helicopters in clutter out to the range limits of the missile type used. The turret is configured to carry and fire the HYDRA 70 rocket pod and all that is required is a simple software change.

SPECIFICATIONS (LAV-AD configuration)

SI ECII ICA IIONO (EAT AD COIIII)	guration)
CREW	2 (commander, gunner)
ARMAMENT	1 × 25 mm GAU-12/A Gatling
	Gun, 2 × 4-round pods Stinger
	SAM
AMMUNITION	990 rounds total, 16 Stinger
	missiles
TRAVERSE	360°
ELEVATION/DEPRESSION	+65°/-8°
TURRET ACCELERATION	

(azimuth and elevation)

TURRET VELOCITY
(azimuth and elevation)

OPTICS

2 rad/s²

1 rad/s
integrated FLIR/TV and eye-safe

laser rangefinder sight
FIRE-CONTROL SYSTEM full solution digital fire-on-the-move

SENSORS temperature, wind, pressure, vehicle tilt
TURRET WEIGHT 2676 kg

Status: Entering production. On order for the US Marine Corps (LAV-AD).

Manufacturer: GE Aerospace, Armament Systems Department, Lakeside Avenue, Burlington, Vermont 05401, USA.

Telephone: (802) 657 6000 Telex: 510 2990 028

Fax: (802) 657 6969/6921

AAI 25 mm Minor Calibre Weapons Station

Development

The 25 mm Minor Calibre Weapons Station (MCWS) has been designed and built by AAI under contract to the Naval Surface Weapons Center/David Taylor Research Center/US Marine Corps. The prototype MCWS was completed in 1986 and has been installed on the AAI-built Automotive Test Rig and the USMC LAV and LVTPX12 vehicles. Installation of the MCWS is planned for the AAI developed Propulsion System Demonstrator.

Description

The MCWS is a lightweight, remotely controlled weapon station armed with a McDonnell Douglas Helicopter 25 mm Chain Gun with 87 rounds of armour-piercing and 200 rounds of high-explosive ammunition for ready use; a 7.62 mm EX-34 Chain Gun is mounted coaxially above. Mounted on either side of the turret front is a bank of four M243 electrically operated smoke dischargers. Space has been provided for installation of a single TOW anti-tank guided missile.

The fire control system includes a Texas Instruments Lightweight Modular Sight, low cost panoramic sight and a fire control processor. An AAI-developed turret drive and stabilisation system is fitted as standard, as is an automatic deck clearance system.

SPECIFICATIONS

 CREW
 none

 ARMAMENT
 1 × 25 mm M242 Chain Gun

 coaxial
 1 × 7.62 mm EX-34 Chain Gun

 SMOKE DISCHARGERS
 2 × 4

 AMMUNITION (ready use)
 287

 25 mm
 287

360° at 60°/s powered

elevation -8° to $+60^{\circ}$ at 60° /s, powered WEIGHT (loaded) 1361 kg

TURRET RING DIAMETER 1 m

MAX WIDTH 1.584 m

HEIGHT

to top of weapon station 0.762 m

to top of panoramic sight 1.140 m

DEPTH BELOW DECK 0.921 m

Status: Prototype.

Manufacturer: AAI Corporation, PO Box 126, Hunt Valley, Maryland 21030

- 0126, USA,

traverse

Telephone: (301) 666-1400 Telex: 8-7849 (710) 232-1800



Minor Calibre Weapons Station showing externally mounted 25 mm cannon and 7.62 mm machine gun installed for trials purposes on LAV (8×8) chassis

North American Dynamics M113 Universal Gunmount

Development

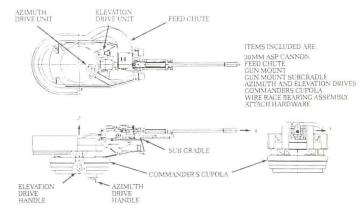
The M113 Universal Gunmount has been in development since it was shown for the first time in July 1986 when it was fitted with an electrically or manually fired McDonnell Douglas Helicopter 30 mm ASP-30 infantry support weapon. If required, other weapon types can be fitted.

It can be installed on a variety of vehicle types with the minimum of modifications and has been trialled on the M113 APC, the FAASV (Field Artillery Ammunition Support Vehicle) and the M109 self-propelled howitzer. Firing trials have also been conducted using the first two vehicles.

The Gunmount can be traversed through 360° using North American Dynamics developed mechanical azimuth and elevation drives under the fitted hatch cover. This will allow the system to be used in both hatch open and hatch closed situations. The elevation range is from -20 to $+45^\circ$.

North American Dynamics is also developing a large format fibre optic cannon sighting system that will allow the same hatch closed/hatch open engagement options to occur. All round vision and target acquisition will be five standard M17 unity prism periscopes with weapon aiming by the $\times\,30$ magnification capability sight.

The M113 and FAASV vehicles' Gunmounts were fitted with a stowable commander's seat assembly. This, traversed in azimuth with the Gunmount, allows the commander to stand with the hatch open or sit with the hatch closed.



Outline drawing of North American Dynamics M113 universal mount armed with McDonnell Douglas Helicopter 30 mm ASP-30 infantry support weapon

Status: Development.

Manufacturer: North American Dynamics, 5721 Research Drive.

Huntingdon Beach, CA 92649, USA.

Telephone: (714) 895-2442

Cadillac Gage Textron 25 mm Turret

Development

This turret has been developed as a private venture by Cadillac Gage Textron and was installed on the V-300 (6×6) and V-150 (4×4) Commando vehicles entered in the LAV competition.

Description

The turret is of all-welded steel construction providing the crew with complete protection from small arms fire and shell splinters. The commander sits on the left and the gunner on the right, both with a single-piece hatch cover opening to the rear.

Main armament consists of a McDonnell Douglas Helicopter 25 mm M242 Chain Gun, with a 7.62 mm M240 machine gun mounted coaxially with the main armament and a similar weapon mounted on the turret roof for anti-aircraft defence.

Turret traverse and weapon elevation are electrohydraulic with manual controls for emergency use. An automatic deck clearance system is provided with power override facilities. The weapons are fired electrically but can be fired manually in an emergency. As an option, full gun/turret stabilisation is available.

The gunner has an M36E1 day/night sight and the commander has eight periscopes for all-round observation. As an option, the commander could have six periscopes and an M36E1 day/night sight.

Standard equipment includes a turret ventilation blower and a 500 000 candlepower spotlight.

Variants

In 1984 Cadillac Gage Textron announced that this turret was also available with electromechanical turret control and stabilisation systems. This model has a maximum turret traverse and weapon elevation speed of 60°/s.



Cadillac Gage Textron 25 mm two-man turret, without pintle-mounted anti-aircraft machine gun, installed on Cadillac Gage Textron V-150 S (4×4) armoured car

Status: Ready for production.

Manufacturer: Cadillac Gage Textron, PO Box 1027, Warren, Michigan 48090, USA.

Telephone: (313) 777 7100 Telex: 200707 CGAGE UR

Fax: (313) 776 9731

SPECIFICATIONS

CREW

ARMAMENT

main coaxial anti-aircraft SMOKE DISCHARGERS 2 (commander and gunner)

1 × 25 mm cannon 1 × 7.62 mm MG

1 × 7.62 mm MG 1 × 7.62 mm MG 2 × 4 AMMUNITION main

coaxial anti-aircraft CONTROL traverse

elevation

230 ready-use (17,0 HE, 60 AP) 400 ready-use 200 ready-use

360° electrohydraulic, 30°/s -8° to +60°, 30°/s OPTICS commander gunner WEIGHT POWER SUPPLY

8 periscopes M36E1 day/night sight 3368 kg 24 V

Delco LAV-25 25 mm Turret

Development

Delco Systems Operations is the prime contractor for the two-man turret installed on the LAV-25 (8 \times 8) vehicle built by the Diesel Division, General Motors of Canada, for the US Marine Corps. For trials, this turret has also been installed on a Canadian Armed Forces M113A1 APC, an 8 \times 8 MOWAG Piranha for the Saudi National Guard, an Alvis Stormer APC and the GKN Desert Warrior. Following trials, Kuwait selected the GKN Defence Warrior with the Delco turret in 1992.

Description

The LAV-25 turret is of all-welded steel armour construction which provides protection against small arms fire and shell splinters. The commander sits on the right and the gunner on the left, both with rear-opening, single-piece batch covers.

The commander has seven M27 unity periscopes for all-round observation and an M36E1 sight for aiming the armament. The gunner has an M27 unity periscope to his left and an M36E1 sight to his front for aiming the armament. The M36E1 sight has a day channel with a magnification of \times 7 and a 10° field-of-view, passive night image intensifier channel with a magnification of \times 8 and an 8° field-of-view and a unity channel with 60° horizontal \times 10° vertical field-of-view for observation.

The M36E1 can be replaced by various other sight models such as: the Delco Improved M36 sight (DIM36); the Delco LAV-25 Thermal Sight (see later); the GITS (see later); the DIM36 with laser rangefinder; and the Delco LAV-25 Thermal Sight with laser rangefinder.

Turret traverse and weapon elevation are electrically driven hydraulic pump type with both commander and gunner having an identical single hand controller. Turret traverse is a full 360° and weapon elevation is from -8 to +60° at 25°/s. The armament is fully stabilised and manual controls are provided for emergency use.

Main armament comprises a McDonnell Douglas Helicopter 25 mm M242 Chain Gun with a 7.62 mm M240 machine gun mounted coaxially to the right. If required, a 7.62 mm M60 machine gun can be pintle-mounted for anti-aircraft defence. Mounted either side of the turret is a bank of M243 four-barrelled smoke dischargers. A sensor in the turret provides the crew with a low ammunition warning.

The turret is also fitted with an NBC subsystem with ventilated face masks for the commander and gunner.

Turret options include a Delco LAV-25 Thermal Sight to provide recognition capability out to 2000 m. The sight utilises the Hughes Infra-Red Equipment (HIRE) thermal subsystem and contains accurate stadia and ballistic reticles and has both wide and narrow fields-of-view. It is compatible with the existing M36E1 sight and uses a biocular video viewer or remote CRT display which is fully operable from the commander's position. The Turret Improved Armour System (IAS), that is a turret armour upgrade, uses various add-on armour types to provide full protection of the frontal 30° arc at 0 m range against 14.5 mm AP rounds (perforated steel/ceramic armour), full protection of the sides and rear at 400 m range from 14.5 mm AP rounds (high hardness steel and ceramic armour) and overhead protection (by increased shell thickness and the addition of spall liners) from 155 mm air burst rounds at 10 m range. The TOW Add-On Option with single-tube armoured TOW ATGW launchers is located on either side of the turret and stowed beneath turret line. The TOW lightweight sight and tracker is the GM Hughes Electronics (GMHE) Integrated TOW Sight (GITS), which is obtained by expanding the Delco Thermal Sight with add-on modules. It is shared with the 25 mm cannon and the launch tubes are reloaded by the loader from the chassis to maintain armour protection. There is an NBC upgrade system.

Status: Production - over 450 turrets produced to date with production resumed for foreign orders. In service with Australia, Saudi Arabia and United States Marine Corps on LAV 8 \times 8 chassis.

Manufacturer: Delco Systems Operations, Delco Electronics Corporation, 6767 Hollister Avenue, Goleta, California 93117, USA.

Telephone: (805) 961 5903 Telex: 910 334 1174 Fax: (805) 961 5416



GKN Defence Warrior mechanised vehicle fitted with Delco LAV-25 25 mm turret and a launcher either side of the turret for a Hughes TOW ATGW (Christopher F Foss)



US Marine Corps Light Armored Vehicle (8 × 8) chassis fitted with Delco LAV-25 turret (US Army/Michael Green)

SPECIFICATIONS		CONTROL		WEIGHT	1815 kg	
CREW	2 (commander	traverse	360° at 25°/s	POWER SUPPLY	24 V	
	and gunner)		hydraulic	LENGTH	4.346 m	
ARMAMENT	3	elevation	-8° to +60° at 25°/s	WIDTH	1.625 m	
main	1 × 25 mm cannon		hydraulic	HEIGHT		
coaxial	1 × 7.62 mm MG	OPTICS		LAV-25 over hull	0.52 m	
SMOKE DISCHARGERS	2 × 4	commander	7 × M27 unity	LAV-25 total	1.332 m	
AMMUNITION			periscopes	CHASSIS OPENING	11002.111	
main	210 ready-use (150		1 × M36E1 sight	LAV-25	0.708 m	
	HEI-T, 60 APDS-T)	gunner	1 × M27 unity	2.1. 23	017 00 111	
coaxial	400 ready-use	garnior	periscope			
smoke grenades	8 × L8A1		1 × M36E1 sight			
orrionto grandaco	0 11 20711		i wilder digiti			

FMC 25 mm Two-man Turret

Development/Description

After limited testing with the 20 mm weapon early in 1975, FMC built a turret that mounted a 25 mm cannon developed by the Ford Aerospace and Communications Corporation. The programme was then redirected by the Government to include development of a new two-man turret, often called the TBAT-II, prototypes of which were built armed with the 25 mm Ford cannon and the 25 mm McDonnell Douglas Helicopter Chain Gun. After extensive trials the M242 25 mm Chain Gun was selected as the main armament, with a 7.62 mm M240 machine gun mounted coaxially to its right and a twin TOW ATGW launcher mounted on the left of the turret. The TOW launcher lies alongside the turret when not required and is quickly elevated through 90° into the firing position. The sighting and controls for both the guns and the missiles are integrated to simplify firing operations. The thermal imaging day/night sight provides \times 4 and \times 12 power viewing to both the commander and gunner. The turret is fitted with a General Electric turret drive and stabilisation system which allows the armament to be laid and fired while the vehicle is travelling across country. This turret is fitted to the M2 Infantry Fighting Vehicle and the M3 Cavalry Fighting Vehicle. In 1981, the year production began, the M2 and M3 were renamed the Bradley Fighting Vehicles. Second year production turrets are equipped with a Kollmorgen commander/gunner backup day sight.

Status: In production. In service with Saudi Arabia and the United States.



FMC Bradley Fighting Vehicle with FMC 25 mm two-man power-operated

Manufacturer: FMC Corporation, Ground Systems Division, 881 Martin Avenue, PO Box 58123, Santa Clara, CA 95052, USA Telephone: (408) 289 2882 Telex: 910 338 0045

SPECIFICATIONS

CREW

ARMAMENT

main coaxial anti-tank

SMOKE DISCHARGERS

2 (commander and gunner)

1 × 25 mm cannon 1 × 7.62 mm MG

twin Hughes TOW launcher

4 either side of turret

AMMUNITION main

coaxial TOW ATGWS CONTROL traverse

elevation

MODES OF OPERATION

manual powered stabilised

300 ready-use in turret

800 ready-use in turret

-10° to +60° electric

2 ready for use

360° electric

at 60°/s

at 60°/s

TOW LAUNCHER

25 mm gun and TOW 25 mm gun and TOW 25 mm gun only -20° to +30° elevation

FMC 25 mm Enclosed Weapon Station

Development/Description

In 1974 the Royal Netherlands Army awarded the FMC Corporation a contract for the development of an improved version of the Armored Infantry Fighting Vehicle. During the development phase four weapon stations were built, including a right- and a left-hand model of the German Rheinmetall 20 mm Rh 202 cannon and a right- and a left-hand model of an Oerlikon-Contraves 25 mm cannon. All four stations were electrohydraulically powered, incorporated a dual-feed ammunition system and a coaxially mounted MAG 58 7.62 mm machine gun. To evaluate the performance of available sights the right-hand models used a Philips UA9124/UA9216 sight and the left-hand models a PERI-Z11 sight. After extensive trials with both models the right-hand 25 mm Oerlikon-Contraves station with the Philips sight was selected.

Although developed by FMC the weapon stations for the Dutch Army were actually manufactured and integrated by DAF Special Products. Over 1000 changes to the original design were engineered by DAF for the production run.

Today the weapon station is available with an Oerlikon-Contraves 25 mm KBA dual-feed automatic cannon and the same coaxial machine gun. The station features a variable-rate control, electrohydraulic power turret drives, and a microprocessor deck clearance system. As an option, the station can be equipped with a Philips day/night sight, and M34 day sight, or an M36E1 sight with integrated night vision. Also included is an emergency gun sight and a coaxially mounted searchlight.

The all-welded turret incorporates an additional layer of spaced laminate armour as fitted to the hull of the AIFV. A modification kit substituting a 12.7 mm M2 machine gun for the Oerlikon-Contraves 25 mm cannon is available, this being the model used by the Philippines.



FMC 25 mm one-man Enclosed Weapon Station installed on AIFV

Status: In production. In service with Belgium, Netherlands, Philippines and Turkey.

Manufacturer: FMC Corporation, Ground Systems Division, 881 Martin Avenue, PO Box 58123, Santa Clara, CA 95052, USA Telephone: (408) 289 2882 Telex: 910 338 0045

SPECIFICATIONS
CREW
ARMAMENT
main
coaxial
AMMUNITION
main
coaxial

1 (gunner)

230 ready-use

1 × 25 mm cannon 1 × 7.62 mm MG 180 ready-use

CONTROL traverse

elevation **OPTICS**

360" electrohydraulic at 60 % -10° to +50° electrohydraulic at 60°/s 5 M27 periscopic 1 Philips sight with magnification × 2 or \times 6 (day) and \times 6 (night), open antiaircraft/emergency sight

WEIGHT unloaded 1230 kg loaded 1460 kg LENGTH 3.49 m HEIGHT ABOVE TURRET RING 0.787 m **DEPTH BELOW** TURRET RING 1.515 m POWER SUPPLY 24 V DC

FMC 25 mm Electric Drive Turret

Development/Description

The FMC electric drive one-man turret has been designed as a private venture by the FMC Corporation for sales outside the USA as a direct replacement installation on the FMC Armored Infantry Fighting Vehicle (AIFV), although the design can also be fitted on the M113 APC or any similar size vehicle. The main improvements on the normal AIFV turret are ballistic protection (using FMC's spaced laminate armour system which gives 14.5 mm of armour protection), the ejection ports and an electrical drive system with optional stabilisation. The turret is armed with the McDonnell Douglas Helicopter 25 mm M242 Chain Gun and for secondary armament is provided with a 7.62 mm M240 (FN MAG) machine gun

The FMC electric drive turret has been designed to integrate proven hardware with new ideas in a low cost, easily maintained, high firepower weapon station. The electrical power supply is the usual 24 V DC, but there is a manual drive system as a backup. For fire control an M36E3 sight is fitted which has a day/night capability and there are four M27 unity periscopes for frontal and side vision; a rear periscope is an optional extra. All the weapon station drives and electronic units are arranged for easy access and the turret slip ring can be removed from inside the turret.

The electric drive turret design was initiated in 1980 and two prototypes have been built and successfully tested.

Status: Development complete. Ready for production pending orders. For trials purposes this turret has been installed on the British Fox light armoured car and is also fitted on the private venture NORINCO/FMC NFV-1 infantry fighting vehicle. As of early 1993 the FMC 25 mm Electric Drive Turret had not entered production and these two vehicles were no longer marketed.



Prototype of FMC 25 mm electric drive turret fitted to M113 APC

Manufacturer: FMC Corporation, Ground Systems Division, 881 Martin Avenue, PO Box 58123, Santa Clara, CA 95052, USA Telephone: (408) 289 2882 Telex: 910 338 0045

SPECIFICATIONS		CONTROL		HEIGHT	
CREW ARMAMENT	1 (gunner)	traverse	360° electric, manual backup at 60°/s	overall minus slip ring above deck, including	1.864 m
main	1 × 25 mm M242 dual-feed automatic	elevation	-7° to +47° electric, manual backup at	bearing below deck, including	0.866 m
en evite!	cannon	TDACKING DATE	60°/s	slip ring	1.168 m
coaxial RATE OF FIRE,	1 × 7.62 mm M240 MG	TRACKING RATE, MINIMUM	0.25 mils/s	AZIMUTH GEAR PITCH DIAMETER	1.016 m
CONTROLLED AMMUNITION	$200 \pm 25 \ rds/min$	STABILISATION	optional add-on system	DECK CLEARANCE POWER SUPPLY	automatic 24 V DC

WEIGHT (combat loaded.

without gunner)

1409 kg

FMC 25 mm Autocannon Turret

Development/Description

main

coaxial

This turret is an adaptation of the FMC 25 mm two-man turret as installed on the M2 Bradley Infantry Fighting Vehicles and M3 Cavalry Fighting Vehicles of the US Army. It is identical except that there is no twin TOW missile system and an M36E1 sight is substituted for the thermal imaging day/night sight. The FMC 25 mm Autocannon Turret is intended to provide a lighter weight, low cost alternative suitable for mounting on M113 or similar vehicles. Testing of the turret on an M113A1 vehicle was completed in 1983.

100 ready-use HEIT

230 ready-use

65 ready-use APDS-T

Status: Development complete. Ready for production.

Manufacturer: FMC Corporation, Ground Systems Division, 881 Martin Avenue, PO Box 58123, Santa Clara, CA 95052, USA Telephone: (408) 289 2882 Telex: 910 338 0045

M113 series APC with FMC 25 mm Autocannon Turret



SPECIFICATIONS CREW	2 (commander and gunner)	CONTROL traverse	360° continuous, electric at 60°/s	gunner	2 periscopes × 5 auxiliary sight (shared with
ARMAMENT	4 05	elevation	-10° to +60°		commander)
main	1 × 25 mm cannon 1 × 7.62 mm MG	OPTICS	electric at 60°/s		× 7 M36E1 day/night sight
SMOKE DISCHARGERS AMMUNITION	4 either side of turret	commander	7 periscopes × 5 auxiliary sight	WEIGHT (with guns and ammunition)	2600 kg
main, ready-use in turret	300 (225 HE, 75 AP)		(shared with gunner)	POWER SUPPLY	24 V DC

Cadillac Gage Textron 20 mm Turret

This turret was originally designed by Cadillac Gage Textron for its V-150 Commando armoured vehicle but is now being offered for other tracked and wheeled AFVs and has already been successfully tested, mounted on the M113A1 APC.

Description

The Cadillac Gage Textron 20 mm turret is a two-man armoured turret armed with a 20 mm GAD-AOA (previously Oerlikon-Contraves 204 GK) cannon, a coaxial 7.62 mm machine gun and a commander's ring mount with a pintle-mounted 7.62 mm machine gun. The turret can be rotated through 360° under power at speeds of up to 60°/s and a minimum smooth tracking rate of 1 mil/s. The 20 mm cannon has an elevation of +60° and a depression of -8° with a maximum powered traverse speed of 40°/s. A dual-control system allows either the commander or the gunner to operate and fire the weapon. If the electrohydraulic power system is damaged emergency mechanical hand-operated controls can be used. The turret is also equipped with a hydraulic charger internally controlled, a turret ventilating blower, an emergency firing trigger for the cannon and a rate controller which allows the firing of one, two or four rounds per second or full automatic mode. For night surveillance a 200 mm 500 000 candlepower spotlight is mounted coaxially with the 20 mm cannon. The electrohydraulic power system components are scaled-down versions of the ones used in M60 and Leopard 1 production MBTs. The turret armour will defeat 7.62 mm AP ammunition at 0° obliquity and point-blank range.

The turret is designed for a crew of two: commander and gunner. Optional equipment includes smoke/fragmentation dischargers, and optical and vision device washers and wipers.



Cadillac Gage Textron 20 mm turret on Cadillac Gage Textron V-150 (4 × 4) armoured car

Status: Production as required. In service with undisclosed countries. By early 1993 over 100 of these turrets had been built.

Manufacturer: Cadillac Gage Textron, PO Box 1027, Warren, Michigan 48090 USA

Telephone: (313) 777 7100 Telex: 200707 CGAGE UR

Fax: (313) 776 9731

SP	FC	IFI	CA	TIC	ONS

CREW

ARMAMENT

main coaxial anti-aircraft gunner)

1 × 20 mm cannon 1 × 7.62 mm MG

1 × 7.62 mm MG

2 (commander and coaxial anti-aircraft

CONTROL

main

AMMUNITION

traverse

elevation

OPTICS

200 ready-use in turret 400 ready-use in turret

200 ready-use in ring

mount

360° electrohydraulic

at 60°/s

-8° to +60° electrohydraulic at 40°/s

commander

gunner

WEIGHT (less crew) POWER SUPPLY

4 direct vision blocks 360° traverse periscope monocular × 8 magnification sight unity power periscope with projected graticule

1905 kg 24 V

Cadillac Gage Textron 20 mm 1 m Turret

Development/Description

The Cadillac Gage Textron 20 mm turret is a one-man armoured turret fitted with a 20 mm Oerlikon-Contraves GAD-AOA cannon, 7.62 mm MAG coaxial machine our and optional smoke/fragmentation grenade launchers.

The turret can be rotated through 360° under power at up to 60°/s and a minimum smooth tracking rate of 1 mil/s. The 20 mm cannon can be elevated from -8 to +55° with movement under power at speeds of up to 40°/s. If the electrohydraulic power system is damaged emergency mechanical hand-operated controls can be used. The turret is also equipped with an internally controlled hydraulic charger, turret ventilating blower, emergency firing triggers and a rate controller for the 20 mm cannon which allows firing of single, two or four rounds per second or full automatic mode. For night surveillance a 200 mm 500 000 candlepower spotlight is coaxially mounted with the 20 mm cannon. The electrohydraulic controls are scaleddown versions of the ones fitted to the M60 and Leopard 1 series of MBTs.

The turret provides all-round vision for the gunner by means of eight direct-view vision blocks, which allow for instantaneous 360° vision. The gunner's periscope is a ×8 monocular sight and unity periscope with a projected graticule. In addition to the main sight, the turret is equipped with an external anti-aircraft sight. The frontal armour of the turret will defeat 12.7 mm AP projectiles at 425 m and the remainder 7.62 mm AP at pointblank range and 0° obliquity.

The turret may be equipped with smoke/fragmentation launcher tubes. These electrically fired grenade launchers are pre-aimed to cover a fanshaped area beginning 36 m in front of the turret and ending at 50 m. The width of the fan is about 170°. Optional equipment includes add-on electrohydraulic stabilisation system, and optical and vision device washers and wipers.



Cadillac Gage Textron 20 mm 1 m turret on M113A1 APC

This turret incorporates most of the components used in the Cadillac Gage Textron 20 mm two-man turret and the one-man 1 m machine gun

Status: Development complete. Ready for production on receipt of orders.

Manufacturer: Cadillac Gage Textron, PO Box 1027, Warren, Michigan 48090, USA

Telephone: (313) 777 7100 Telex: 200707 CGAGE UR

Fax: (313) 776 9731

SPECIFICATIONS

CREW ARMAMENT main

coaxial AMMUNITION main

coaxial

1 (gunner)

1 × 20 mm cannon

1 × 7.62 mm MG

200 ready-use in turret 400 ready-use in turret

CONTROL traverse

elevation

360° electrohydraulic

-8° to +55° electrohydraulic, at 40°/s

OPTICS

8 vision blocks monocular sight magnification × 8 unity power periscope with projected graticule, external

WEIGHT (less crew) POWER SUPPLY

anti-aircraft sight 1224 kg 24 V

Cadillac Gage Textron Twin/Combination Machine Gun (1 m) Turret

Development

This turret was originally designed by the Cadillac Gage Textron for its V-150 Commando (4×4) vehicle but is now being offered for other vehicles and has already been adopted by the Canadian Armed Forces for its Grizzly Wheeled Armoured Personnel Carriers.

Description

The 1 m turret is operated by one person and is capable of mounting many different configurations of weapons, including twin 7.62 mm or twin 0.50 calibre machine guns, and may also be equipped with a combination of 7.62 mm/0.50 machine guns. It can also be fitted with a 40 mm grenade launcher in lieu of one of the machine guns.



Cadillac Gage Textron twin/combination machine gun (1 m) turret armed with 7.62 mm and 0.50 machine guns installed on Grizzly Wheeled Armoured Personnel Carrier of the Canadian Armed Forces (UK MoD)

The turret is manually rotated and can be traversed continuously through 360°. The traverse mechanism incorporates a manual friction brake which is foot operated and a friction 'drag' mechanism. The brake is used to hold the turret in a fixed position and the 'drag' mechanism allows it to be rotated with a fixed resistance, enabling the gunner to lay on the target more accurately. The weapons can be elevated from -10 to $+55^\circ$ through a manual jack screw mechanism. Ammunition is fed to the weapons from standard ammunition boxes, eliminating the need for feed chutes and allowing for rapid reload. Additional ready ammunition may be made available if the turret is not equipped with radio sets in the turret bustle. Weapons are fired electrically, singly or in unison. In the event of an electrical failure they may be manually operated.

The turret has a monocular M28C sight with a magnification of \times 1.5 which is driven by the movement of the turret cradle, ensuring correct sighting at all times. All-round observation for the gunner is by eight direct vision blocks mounted in the upper part of the turret. The gunner has an adjustable seat and the turret is provided with a single-piece hatch cover that opens to the rear and an extractor fan. A 500 000 candlepower searchlight is mounted coaxially with the right machine gun. Optional equipment includes optical and vision device washers, power assist traverse and smoke/fragmentation dischargers.

SPECIFICATIONS

CREW
ARMAMENT
AMMUNITION
7.62 mm MG
per 0.50 MG
CONTROL
traverse
elevation
OPTICS

200 ready-use
360° manual
-10° to +55° manual
8 vision blocks

1 (gunner)

400 ready-use

see text

monocular × 1.5 magnification sight 753 kg

WEIGHT (less crew)

Status: Production as required. In service with a number of countries including Canada (on Grizzly Wheeled Armoured Personnel Carrier). By early 1993 over 1000 of these turrets had been completed.

Manufacturer: Cadillac Gage Textron, PO Box 1027, Warren, Michigan 48090, USA.

Telephone: (313) 777 7100 Telex: 200707 CGAGE UR Fax: (313) 776 9731

Cadillac Gage Textron Machine Gun Turret

Development/Description

This machine gun turret was originally designed by Cadillac Gage Textron for the Commando (4×4) armoured vehicle, but has since been adopted by a number of countries for other vehicles such as the M113 APC. This turret is sometimes called the T-50.

The one-man, manually operated turret may be equipped with twin 7.62 mm or combination 7.62 mm/0.50 calibre machine guns. Laying and control of the weapons are mechanical with a hand-operated gearbox which allows 360° continuous rotation at $45^\circ/s$, and a gunner handle at the rear of a balanced gun cradle for elevation. The weapons may be moved from –14 to +55° and are fired electrically either in unison or singly. In the event of an electrical failure they may be manually operated.



The turret is equipped with a monocular M28C sight with a $\times 1.5$ magnification, which is driven by the movement of the gun cradle, ensuring proper sighting at all times. All-round observation is obtained through eight direct vision blocks. The ballistic protection level of the turret enables it to defeat 7.62 mm AP projectiles at 0° obliquity and point-blank range. Optional equipment includes a 500 000 candlepower spotlight which is mounted coaxially with the machine guns, smoke dischargers and power assist traverse.

SPECIFICATIONS

CREW ARMAMENT AMMUNITION 0.50 MG

1 (gunner) see text

per 7.62 mm MG CONTROL 200 ready-use 400 ready-use

CONTROL traverse elevation

360° manual -14° to +55° manual

OPTICS

8 vision blocks monocular sight with × 1.5 magnification

WEIGHT (less crew)

748 kg

Status: Production as required. In service with a number of countries including Australia (M113 APC), Lebanon (M113 APC) and New Zealand (M113 APC). By early 1993 over 1000 of these turrets had been completed.

Manufacturer: Cadillac Gage Textron, PO Box 1027, Warren, Michigan 48090, USA.

Telephone: (313) 777 7100 Telex: 200707 CGAGE UR Fax: (313) 776 9731

Cadillac Gage Textron machine gun turret on M113 APC

FMC 12.7 mm Machine Gun Turret

Development/Description

In 1964 FMC designed and built eight fully enclosed powered turrets for the Marine Corps LVTPX12 (the prototype of the LVTP7). The one-man turret was hydraulically powered and armed with a 20 mm cannon and a 7.62 mm machine gun, which were aimed using a sight with a magnification of × 8. The turret was subsequently redesigned by FMC to mount the M85 12.7 mm (0.50) machine gun and was eventually standard for all production LVTP7s with 998 turrets produced between 1970 and 1974.



FMC 12.7 mm machine gun turret as installed on all production AAVP7A1 amphibious assault vehicles

In early 1982 the US Marine Corps awarded FMC a contract to rebuild 853 turrets to the AAVP7A1 configuration and to build 349 new turrets.

The one-man turret is of welded aluminium construction with a singlepiece hatch cover that opens to the rear. The machine gun has two rates of fire, 450 rds/min (low cyclic) and 1050 rds/min (high cyclic).

In 1980 the turret was modified to mount the M257 grenade launching system, and the turret drive system was replaced with a low maintenance electric servo system. There is a manual drive system for backup should the electrical system be disabled. The turret is mounted on the AAVP7A1

SPECIFICATIONS (turret as fitted to AAVP7A1)

CREW 1 (aunner) ARMAMENT 1 × 12.7 mm MG AMMUNITION 400 ready-use in turret

CONTROL

360° electrotraverse mechanical at 60°/s

-15° to +60° electroelevation mechanical at 60°/s OPTICS

8 vision blocks indirect optical sight × 8 magnification

nominal, x 1 magnification with projected graticule,

direct ring sight

WEIGHT (with gun and ammunition but

without gunner) 696 kg NOMINAL APERTURE

REQUIRED IN VEHICLE

ROOF 0.869 m

HEIGHT OF TURRET (above vehicle roof) 0.635 m POWER SUPPLY 24 V

Status: Production as required. In service with Argentina, Italy, South Korea, Spain, Thailand, USA and Venezuela. Most US Marine Corps vehicles now have the Upgunned Weapons Station (UWS) (qv) fitted.

Manufacturer: FMC Corporation, Ground Systems Division, 881 Martin Avenue, PO Box 58123, Santa Clara, CA 95052, USA Telephone: (408) 289 2882 Telex: 910 338 0045

Electronics & Space Corp TOW Under Armour (TUA) Turret

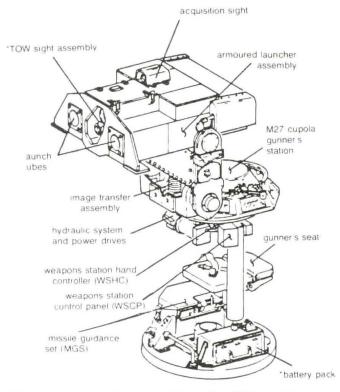
Development

E & S Corp developed the TOW Under Armour (TUA) turret to allow the crew to launch and guide the TOW missile system from defilade whilst also protected by armour. Only one square metre of TUA is exposed to hostile fire and this area is completely separate from the crew location. The TUA tow-tube elevating launcher fires any of the TOW missile variants: Basic TOW, Improved TOW (I-TOW), TOW 2A and future TOW missile configurations. A description of the TOW missile is given in the Vehiclemounted ATGW section of this book.



M901 Improved TOW Vehicle with TUA launcher raised ready to fire

The original E & S Corp TUA turret was designed for the US Army M901/ M901A1 Improved TOW Vehicle (ITV) utilising the M113A1 APC chassis. E & S Corp has produced over 3200 ITVs for the US Army and the National



Major components of Electronics & Space Corp TUA turret (*part of basic TOW ground system)

The TUA was designed to be compatible with a wide range of tracked and wheeled armoured fighting vehicles. In addition to the US Army's ITVs, E & S Corp has produced TUAs on the OTO Melara VCC-1 chassis for Saudi Arabia, 96 TUAs on the Light Armored Vehicle (LAV) chassis for the US Marine Corps and 314 TUAs on the YPR-765 PRAT tracked vehicle for the Royal Netherlands Army. More than 4000 TUA turrets have been delivered to date by E & S Corp, with production continuing. Delivery will soon start on over 100 systems on the LAV (8 × 8) chassis for Saudi Arabia.

In addition to the fielded vehicles already mentioned, E & S Corp has successfully integrated TUA on several other vehicles including the Cadillac Gage Textron V-300 (6 \times 6), the OTO Melara C-13, the Talbot M-41E, the GKN Defence Simba (4 \times 4) and the MOWAG Piranha (8 \times 8).

Description

In addition to the two missile launching tubes, the elevating launcher includes the gunners optics (TOW daysight and thermal night sight), a \times 4 magnification wide field-of-view and a \times 12 magnification target acquisition sight. TOW missile guidance is accomplished with the standard Missile Guidance Set (DGMS) mounted inside the crew compartment. The elevated launcher interfaces with the vehicle using a standard M27 cupola, which makes it compatible with most US and allied armoured combat vehicles.

The TUA has fully powered 360° traverse movement with its 'hammer head' having a elevation of $+34^\circ$ and depression of -30° . This enables the system to operate on gradients and side slopes with only the launcher head showing above the crest. When travelling, the launcher head is retracted on top of the vehicle hull making the vehicle difficult to distinguish from a standard AFV. It requires only 20 seconds for the launcher to be elevated and the target to be engaged. The time from first TOW missile impact to second round triggering with up to 12.5° target separation is 4.25 seconds.

The protected gunner identifies and tracks the target with the sight's narrow field-of-view via the image transfer assembly. He can select either the day sight or night sight by remote control. The wide field-of-view allows the gunner to scan the terrain and locate targets. The guidance and sights of the TUA are identical to the standard TOW ground launcher system and, if required, these components can be removed from the vehicle and fitted to the ground TOW launcher tripod that is carried inside the vehicle. Once two TOW missiles have been fired the launcher head is depressed at the rear and two reload rounds are fitted. The loader is provided with side and overhead armour protection during the 40 second loading operation. In addition to the two ready-to-launch TOW missiles, a further 10 TOW rounds can be mounted inside the vehicle. For local defence a 7.62 mm machine gun with 2000 rounds of ammunition is mounted on the cupola.

TUA Variants

E & S Corp also developed the US Army's M981 Fire Support Team Vehicle (FISTV). This is configured to duplicate the appearance of the M901 ITV but is designed to locate and designate targets. The same elevating platform is used, however, and the TOW optics are replaced by the AN/TVQ-2 Ground Laser Locator/Designator (GLLD). The FISTV includes a north-seeking gyroscope, a land navigation system and extensive communications equipment located inside the vehicle.

The system provides target identification, acquisition and designation to artillery units, enabling them to achieve 'first-round fire for effect' hits with both conventional and laser guided smart munitions. Over 1300 FISTVs have been produced by E & S Corp for the US Army and the Egyptian Government has procurred 25 Artillery Target Locating Vehicles (ATLV), the international variant of the FISTV.

TUA/FISTV Upgrades

Service Life Enhancement Programmes (SLEP) available for the M901/M981 vehicles include:

- (a) Commander's Video Viewing Device to give the commander a remote view of the gunner's sight imagery via a video link. This will greatly improve the commander's ability to conduct surveillance and target identification as well as improving the training capabilities (for both ITV and FISTV)
- (b) NBC upgrade to install NBC filters and ventilated face masks for the crew (for ITV, which currently lacks an onboard NBC system)
- (c) Automatic Turret Positioning to solve the difficulties in positioning the 'hammer head' in the stow/load position whilst under fire (for both ITV and FISTV)
- (d) Integrated Global Positioning System (GPS) an interface for existing GPS units to allow 15 m CEP accuracy in obtaining vehicle position (for FISTV)
- (e) Enhanced AN/TAS-4 Night Sight Collimation the fitting of remote night sight adjustment controls which are accessible within the vehicle so as to keep crew under armour during and reduce time taken for collimation task (for both ITV and FISTV)
- (f) Night sight lens cover a protective cover installed on the face of the launcher sight system to reduce potential for battlefield damage as well as frequency of cleaning (for ITV)
- (g) Low voltage sensor to identify battery low voltage by audible warning whilst there is still sufficient battery energy available for engine and

- start. During 'silent watch' periods the battery can be rapidly drained (for both ITV and FISTV)
- (h) North seeking gyro emergency power supply low battery voltage can currently cause the North seeking gyro to re-initialise. As this takes 10 minutes before the system is fully operational again the emergency power supply is designed to prevent this loss of operational capability and extend system operating time under such circumstances (for FISTV)
- (i) HYDRA 70 unguided rocket
- (j) Laser filter the current Fielded Image Transfer Assembly wide fieldof-view does not provide laser filter protection. A laser filter is to be installed in the objective lens to allow easy field upgrades to protect against laser illumination (for ITV)
- (k) RISE power upgrade (for both ITV and FISTV).

The US Army and National Guard are to introduce all the above improvements save the addition of the HYDRA rocket because of the need to keep these vehicles in the inventory for longer than originally planned as well as correcting certain operational problems identified during 'Desert Storm'. The development of the two SLEP packages is currently funded through FY94 with application projected to begin at the Red River Army depot during the fourth quarter of FY94 and scheduled to continue at the rate of one active army division set through FY98.

SPECIFICATIONS (TUA)

 CREW
 1 (gunner)

 ARMAMENT
 twin TOW ATGW launcher

 secondary
 1 × 7.62 mm MG

 smoke dischargers
 optional

 AMMUNITION

TOW 2 plus 10 7.62 mm 2000 CONTROL

traverse 360° traversing rate 35°/s elevation/depression +34°/-30° OPTICS

TOW daysight × 2.8 magnification, 25° field-of-view × 13 magnification, 5.5° field-of-view TOW AN/TAS-4 infra-red night vision sight field-of-view

 \times 12 magnification, 1.1° \times 2.2° narrow field-of-view Squad Leader's periscope 360° traverse, +10°/-20° elevation

Squad Leader's periscope 360° traverse, +10°/-20° elevatic depression, × 4 magnification, 12.5° field-of-view

LAUNCHER HEIGHT ABOVE VEHICLE TOP (M901)

 stowed
 1.08 m

 raised
 1.52 m

 POWER SUPPLY
 24 V DC

Status: In production. In service with Egypt (52), Greece (24), Jordan (50), Kuwait (58), Netherlands (314), Pakistan (24), Saudi Arabia (224) and the USA (US Army and US Marine Corps).

Manufacturer: Electronics & Space Corp, 8100 W Florissant Avenue, St Louis, Missouri 63136, USA.

Telephone: (314) 553 3334 Fax: (314) 553 3517



US Marine Corps Light Armored Vehicle (8 \times 8) anti-tank fitted with TUA with launcher in stowed position for travelling

Electronics & Space Corp Ground-Launched Hellfire-Heavy (GLH-H) Turret

Development/Description

The GLH-H two-man turret assembly was designed to enable Rockwell AGM-114 Hellfire missiles to be fired from armoured vehicles. It is being trialled on an M113 APC but can also be installed on many other tracked and wheeled vehicles such as the LAV, M2/M3 Bradley and M551 Sheridan.

The turret is of modular design and uses Hellfire system components. A total of six ready-to-fire missiles are carried, with three in each of two launcher assembly units on either side of the turret. Typically, six reload rounds are carried in the hull of the platform vehicle. Reloading of the launcher assemblies takes 15 minutes.

Details of the Rockwell Hellfire modular missile system can be found in the *Vehicle-Mounted Anti-Tank Guided Weapons* section. Both autonomous (laser illumination of the target is provided by the launch platform) and cooperative (indirect fire, the target is illuminated by an off-vehicle laser source) engagement modes are possible.

SPECIFICATIONS

HEIGHT (above turret ring to	
top of launcher assembly)	1.016 m
DEPTH (below turret ring)	1.007 m
WIDTH (max launcher assembly	
to launcher assembly)	2.667 m
TURRET FIRING COVERAGE	
elevation/depression	+35°/-20°
traverse	360°
TURRET TERRAIN OPERATION	
longitudinal	±20°
lateral	±10°
TURRET REACTION TIMES	
stow to target engagement	20 s
traversing rate	65°/s
TARGET ENGAGEMENT RATE	
autonomous mode	6 targets/min
co-operation mode	6 targets/min

ARMAMENT	
main	2 × 3 Hellfire missiles
secondary	1 × 12.7 mm MG
AMMUNITION	
main	6 ready-to-fire + 6 reload Hellfire missiles
secondary	750 rds 12.7 mm
MISSILE ENGAGEMENT LIMITS	
autonomous mode	750-5000 m
co-operation mode	750-8000 m
OPTICS	
Gunner's Sight Unit	
ELEVATION/DEPRESSION	+35°/-20°
DAY CHANNEL	
wide	× 4 magnification, 15° FOV
narrow	× 12 magnification, 5° FOV
NIGHT CHANNEL	
wide	× 4 magnification, 3.3° × 6.6° FOV
narrow	× 12 magnification, 1.1° × 2.2°
	FOV
LASER RANGE	
designation mode	>5000 m
ranging mode	$9000 \pm 10 \text{ m}$
Commander's Sight Unit	
ELEVATION/DEPRESSION	+10°/-20°
MAGNIFICATION	× 4
FIELD-OF-VIEW	12.5°

Manufacturer: Electronics & Space Corp, 8100 W Florissant Avenue, St

Status: Technical feasibility demonstration trials complete.

Telephone: (314) 553 3334 Fax: (314) 553 3517

Louis, Missouri 63136, USA.

Weapon Control and Stabilisation Systems

FRANCE

SAMM Electric Stabilised Drive Controls

Development/Description

The SAMM series of electric stabilised drive controls are designed to provide a quick alignment and accurate tracking of the target for any type of anti-tank or anti-aircraft turret or gun mount.

They are compatible with all types of weapon stabilisation systems and can be integrated with digital or analogue fire-control system computers as new or as part of a retrofit package.

A system typically comprises:

- (a) a two axis servo-amplifier box
- (b) vehicle commander control station
- (c) gunner control station
- (d) traverse DC motor with tachogenerator
- (e) elevation DC motor
- (f) interconnecting cable set
- (g) hull and turret gyrometers as applicable.

The controls are of the speed-progressive type with the turret or gunmount traversed and elevated by variable excitation DC motors which are slaved to the commands given from the control station potentiometers by tachogenerators and by gyrometers when applicable.

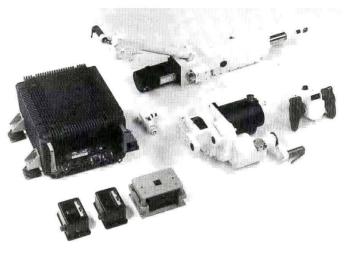
The DC motors are supplied with low voltage from the single low bulk servo-amplifier, which receives the external analogue or digital fire correction signals and are connected directly to the 24 V DC supply of the vehicle. This power stage acts as a reversible power converter with continuous conduction and is effectively an H-bridge current chopper that enables control to be exercised in all four quadrants. Energy recovery for this bidirectional system set up is from the batteries during the braking phases.

Compensation for vehicle movement during firing is optionally provided through a weapon stabilisation system. The aiming error is typically less than 0.5 mil so that the gun remains aimed on the target even when the vehicle is moving over very rough terrain.

The presence of current feedback enables the slaving to be adapted to the load variations as seen by the mechanical drive. The pass-band of the transfer function between the turret and the command signal is then high and depends only on the stiffness coefficient of the reducer. This results in an efficient stabilisation system at high frequencies, especially along the elevation axis

The drive types available are:

- TE 06 drive, 4 kW class which is suitable for:
 - (i) APC/ICV/AFV 20-40 mm gun turrets from 1 to 4 tons in weight
 - (ii) 60/75/76/90 mm light gun turrets
 - (iii) 20 to 30 mm light AA gun mounts and turrets
 - (iv) radar and missile launcher platforms
 - (v) retrofit kits such as 40 mm gun mount modernisation
- TE 30 drive, 10 kW class which is suitable for:
 - (i) 25 to 60 mm heavily armoured ICV turrets
 - (ii) 90 to 105 mm light AFV and tank gun turrets



SAMM electric stabilised drive controls

- (iii) AA turrets and heavy gun mounts
- (iv) heavy gun mount retrofit
- (v) light tank and AFV retrofits such as for the AMX-13, M41 and EE-9 Cascavel
- TE 60 drive, 18 kW class which is suitable for:
 - 105 to 120 mm medium and heavy MBT turrets
 - (ii) twin 35 mm, twin 40 mm, 57 mm AA turrets and gun mounts
 - (iii) 155 mm howitzer turrets
- (iv) Leopard 1, Leopard 2, AMX-30, M48 and similar MBT retrofits
- TE 80 drive, 20 kW plus class which is suitable for:
 - (i) new build 40 to 50 000 kg class MBTs
 - (ii) heavy howitzer turrets with exceptional unbalances
 - (iii) heavy AA turrets.

If required only part of the drive, such as: servo-amplifier, joysticks and control stations, or a stabilisation kit (including types suitable for existing hydraulic drives), can be supplied for inclusion in a retrofit programme.

Status: Development complete. Ready for production.

Manufacturer: Société d'Applications des Machines Motrices (SAMM), Chemin de la Malmaison, F-91570 Bièvres, France. Telephone: (33) (1) 69 35 80 00 Telex: 933-1 69 41 15 72

Fax: 33(1) 69 35 81 98

SAMM CE 10 Electric Turret Drive System

Development/Description

The CE power control unit provides two axes aiming for light turret and missile launcher power drives. The unit includes actuation and control stations and can be linked to all types of fire-control systems via analogue or digital interface technology

The compact CE 10 is directly supplied by the 24 V DC vehicle power supply and is designed with state-of-the-art control station ergonomics. Each of the two half bridge type power phases is sized to supply the axis power drive DC motors with a maximum output of 1 kW. The motors are equipped with tachogenerators to close the speed control servo loop.

A typical CE 10 equipped turret power drive system would comprise the following subsystems:

- (a) a CE 10 two-axis power control unit
- (b) a motor and gearbox traverse actuator
- (c) a motor and jack (or gearbox) elevation actuator
- (d) separate gunner's and commander's control stations
- (e) interconnecting cable set
- (f) optional control panel.

Status: Ready for production. Prototype systems have been successfully



SAMM CE 10 electric turret drive system showing main components

Manufacturer: Société d'Applications des Machines Motrices (SAMM), Chemin de la Malmaison, F-91570 Bièvres, France Telephone: (33) (1) 69 35 80 00 Telex: 933-1 69 41 15 72

Fax: (33) (1) 69 35 81 98

SAMM CE 15 Electric Turret Drive System

Development/Description

The CE 15 is a one axis power control unit that generates a maximum output of 1 kW and is used with the SAMM TE 01 and TE 03 drive types.

Status: Production as required (over 4000 produced to date). The TE-01 is used in the AMX-10 armoured vehicle turret and the TE 03 is used in an export 20 mm turret design.

Manufacturer: Société d'Applications des Machines Motrices (SAMM). Chemin de la Malmaison, F-91570 Bièvres, France.

Telephone: (33) (1) 69 35 80 00 Telex: 933-1 69 41 15 72

Fax: (33) (1) 69 35 81 98

SAMM CE 24 Electric Turret Drive System

Development/Description

The CE 24 is a two axes power control unit that uses analogue technology and provides a maximum power output of 3 kW for the traverse axis and 1 kW for the elevation axis. It can be used with aiming drives for light (less than 1000 kg weight) up to medium (not more than 4000 kg in weight) armoured fighting vehicle turrets.

A total of 14 drive type prototypes (TE 05 to TE 18) have been produced for the CE 24 unit for use on various new build AFV programmes and retrofits

SPECIFICATIONS 45 000 m2 kg inertia turret

TRAVERSE

max speed 1.7 rad/s min speed 0.1 mrad/s

1000 m² kg inertia weapon (with a 1000 Nm unbalance torque)

FLEVATION

0.85 rad/s max speed min speed 0.1 mrad/s

Status: Production as required. Used on a 25 mm coastal gun turret of undisclosed country.

Manufacturer: Société d'Applications des Machines Motrices (SAMM), Chemin de la Malmaison, F-91570 Bièvres, France. Telephone: (33) (1) 69 35 80 00 Telex: 933-1 69 41 15 72

Fax: (33) (1) 69 35 81 98

SAMM CE 40 Electric Turret Drive System

Development/Description

The CE 40 compact lightweight drive system can be fitted either at build or as a retrofit kit for Class 40 tanks, self-propelled guns and anti-aircraft systems.

It is designed for installation in turrets weighing up to 20 000 kg with an inertial moment of 50 000 m2 kg and can be interfaced with the latest optronic fire-control systems. It can also be coupled to a stabilised sighting assembly such as a SFIM tank gunner's roof-mounted sight or SAGEM stabilised gun sight. The modularity of the CE 40 allows for eight power configurations that cover the TE 30 to TE 80 drives for turrets of 4000 up to the maximum 20 000 kg. The CE 40 stabilised system is used in the KUKA E4A1 and SAMM TT 140 turrets.

The main components include elevation and traverse motors, vehicle commander (single handle) and gunner (dual handle) controls, hull and turret gyrometers and a central control box. Total weight of the control box and the two control motors is less than 130 kg. The power supply required is the vehicle's own 24 V DC system.

SPECIFICATIONS 45 000 m2 kg inertia turret

TRAVERSE acceleration >0.9 rad/s max speed >0.75 rad/s <0.1 mrad/s min speed



SAMM CE 40 electric turret drive system

7500 m² kg inertia weapon with a 1000 Nm unbalance

TRAVERSE

>0.9 rad/s acceleration max speed >0.65 rad/s <0.1 mrad/s min speed

Status: In production. In service with the French Army (on AMX-30 Combat Engineer Tractor).

Manufacturer: Société d'Applications des Machines Motrices (SAMM), Chemin de la Malmaison, F-91570 Bièvres, France. Telephone: (33) (1) 69 35 80 00 Telex: 933-1 69 41 15 72

Fax: 33 (1) 69 35 81 98

SAMM PCE 21 G 15 Gunner's Weapon Control Station

Development/Description

The PCE 21 G 15 electrically powered gunner's weapon control station can be used for the aiming of anti-tank, general-purpose or anti-aircraft cannon turret systems fitted with either electric or electrohydraulic drive systems. It is in production for use on 20 to 30 mm calibre retrofitted turrets.

The operator's handle is mechanically connected to two potentiometers with the control voltage being proportional to the manual inclination movements performed when the handgrips are operated. The control voltages can be reversed by inverting the handle direction. Each handle can also be fitted with a varying number of push-button controls for functions such as firing, laser rangefinding and so on.

The maximum travel in both axes is ±20° with the handgrips automatically returned to their zero settings by springs. The body of the handle can be mounted vertically or horizontally according to the customer's preference. If required an integral control panel can be incorporated into the station.

Three versions are currently offered:

PCE 21 G 15 D - horizontal mounting with incorporated control panel

PCE 21 G 15 E - horizontal mounting without control panel

PCE 21 G 15 F - vertical mounting.



SAMM PCE 21 G 15 gunner's weapon controls are of the twin handle type

Status: Production. In service in retrofitted 20 and 30 mm cannon turrets of unspecified countries.

Manufacturer: Société d'Applications des Machines Motrices (SAMM), Chemin de la Malmaison, F-91570 Bièvres, France.

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Telephone: (33) (1) 69 35 80 00 Telex: 933-1 69 41 15 72

Fax: 33 (1) 69 35 81 98

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CSEE-Défense Electric Gun and Turret Drives

Development/Description

The CSEE produce a series of electric gun and turret drive systems for light up to heavy type armoured fighting vehicles.

The current systems available are: Heavy Turret - 'Leclerc' type

This comprises the following individual components:

- (a) electronic drive
- (b) elevation motor
- (c) elevation amplifier
- traverse motor
- traverse amplifier
- energy accumulator
- power converter (g)

The system is capable of the following performance:

Inertia (slug.ft2)

mertia (siug.it)		
traverse	26 000-40 000	
elevation	4000-9000	
Unbalance (lb.ft)		
traverse	5000-7500	
elevation	700-1500	
	Traverse	Elevation
Amplifier peak power	45 kW	15 kW
Max speed	0.8 rad/s	0.7 rad/s
Min speed	0.1 mil/s	0.1 mil/s
Max acceleration	0.75 rad/s ²	1.6 rad/s ²
Accuracy		
fixed target	0.1 mil	0.1 mil
moving target	0.2 mil	0.2 mil
Laying time (V=0 to V=0)		
180°	5 s	1.5 s
90°	3.2 s	(-10 to +20°)
45°	2.5 s	

Medium and Light Turrets 'Start' Mk 1, 2 and 3.

The 'Start' system is based on a modular concept with the following versions available:

Start IVIK	rraverse	Elevation	Applications
1	'linear power'	'linear power'	light turrets (<8000 kg -
			M41 and T-series tanks)
2	constant power'	'linear power'	medium turrets balanced
			guns (M48 MBT)
3	constant power'	'constant power'	medium turrets
			unbalanced guns
			(AMX-30 and Leopard 1

A typical fit for a modified T-series tank would comprise:

- 'Start' power unit (linear power for both aces)
- elevation motor
- (C) elevation gearbox
- (d) traverse motor
- traverse gearbox (e)
- gunner's hand station (f) commander's hand station. (q)

The 'Start' family is capable of the following typical performance:

TURRET WEIGHTS	2000-12 000 kg
Power	9 kW (linear or constant power)
Power unit weight	30 kg
Power supply	24 ± 6 V DC
Max speed	0.61 rad/s
Min speed	0.1 mil/s
Max acceleration	0.84 rad/s ²
Laying time (V=0 to V=0)	180°, 6s

Note: Inertia = 16 300 slug.ft2

Status: Production as required.

Manufacturer: CSEE-Défense, Z A de Courtaboeuf, Avenue des Tropiques,

BP 80, F-91943 Les Ulis Cedex, France.

Telephone: 33 (1) 69 86 85 00 Telex: F600 015 CSEE OY

Fax: 33 (1) 69 07 03 70

GERMANY

Telefunken Systemtechnik Electrical Weapon Control and Stabilisation Systems

Development/Description

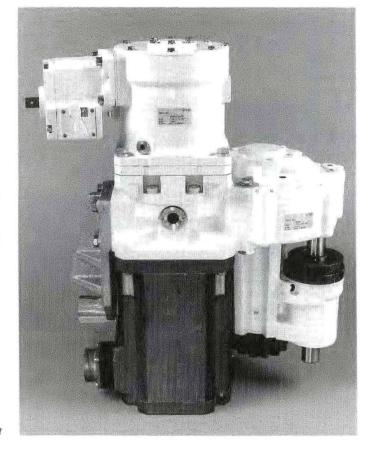
Since the mid-1970s Telefunken Systemtechnik (and its forebears) have produced electrical weapon and turret drive systems for various types of armoured fighting vehicles including the Wildcat self-propelled anti-aircraft gun system, an upgraded M41 light tank (Note: Danish Army's M41 DK-1) and the Israeli Army's Merkava MBT.

In 1990 Telefunken Systemtechnik introduced the new generation of electrical turret/weapon drives with brushless motors. Known as the Type GEARDRIVE 90 BL, one application is combat improvement of the Leopard

Status: Production of system types as required. In service with unspecified NATO countries and Israel.

Manufacturer: Telefunken Systemtechnik GmbH - Deutsche Aerospace AG - Energy and Systems Technology, Industriestrasse 23-33, D-2000 Wedel (Holst), Federal Republic of Germany.

Telephone: (04103) 60-0 Telex: 2 189 520 Fax: (04103) 60 59 18



Azimuth drive unit

FWM Gun Control and Stabilisation Systems

Development/Description

The FWM (Feinmechanische Werke Mainz), Division Ordnance Systems, has over the last 30 years developed and produced a number of gun control and stabilisation systems for use in the armoured fighting vehicles of the German Army. It has also designed and developed other systems specifically for use on export armoured vehicles and as retrofit packages for older vehicle types.

Systems produced so far are as follows:

1) Leopard 2 MBT dual axis electrohydraulic gun control and slaving system with slaving, power control and manual modes of operation. In the slaving mode the gun and turret are automatically slaved to the fire-control system's self-stabilised optical sight. As an option the system can also be equipped with a self-stabilised mode.

2) Leopard 1 MBT dual axis electrohydraulic gun control and stabilisation system with power control, self-stabilised and manual modes of operation. In the stabilised mode the turret and gun position are corrected automatically. As an option the system can also be equipped with an automatic slaving mode to a leading stabilised sight.

3) TAM MBT dual axis electrohydraulic gun control and stabilisation system with slaving, self-stabilisation, power control and manual modes of operation. In the stabilised mode the turret and gun position are corrected automatically. In the slaved mode the system can be automatically slaved to the commander's self-stabilised sight.

4) M48 MBT electrohydraulic gun control retrofit package with basic power control and manual modes of operation. In this form the system can be coupled to a mechanical fire-control computer such as the M13. Optional operating modes include slaving, so that the gun and turret positions are corrected automatically, and self-stabilisation so that the gun is coupled automatically to a self-stabilised sight. With one or both options fitted the system can be fully integrated into any electronic fire-control system available.

5) Luchs reconnaissance vehicle electrohydraulic gun control system with power control and manual modes of operation. The system can also be used on other types of reconnaissance vehicles and APCs to control light turrets and automatic cannon.

Both the commander and gunner have control handles. The commander can override the gunner and control the turret and gun in both the elevation and azimuth axes. Manually operated mechanical inputs are provided to the elevation and azimuth drive to allow control when the hydraulic power mode is inoperative. When it is operative the manually operated inputs are automatically disengaged.

Cocking of the turret's cannon is effected automatically by a cocking cylinder controlled by a solenoid valve.

As an option a self-stabilised and/or slaving mode can be fitted.

6) Marder 1 APC electrohydraulic gun control system with power control and manual modes of operation. The system can also be used to control automatic cannon and light turrets on other APC types and reconnaissance vehicles.

Both the commander and the gunner are provided with hand controllers, with the commander having override facilities to control the turret and gun in the azimuth and elevation axes. A central hand pump is provided for the manual mode when the hydraulic power is inoperative. The external machine gun and automatic cannon are cocked hydraulically by cocking cylinders which are controlled by solenoid valves.

As an option, stabilisation and/or slaving modes can be fitted to the basic system.

7) VCTP APC electrohydraulic gun control system with power control and manual modes of operation. The system can also be used on other APC types and reconnaissance vehicles for controlling their light turrets and automatic cannon. The gun and turret position is controlled in elevation and azimuth via the gunner's dual axis hand controller. As an option, the system can be fitted with a stabilisation and/or slaving mode.

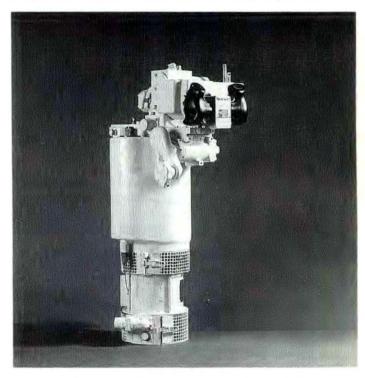
Cocking of the automatic cannon and operation of its trigger are both effected hydraulically by using cocking cylinders controlled by solenoid valves. When the hydraulic power becomes inoperative for any reason a central hand pump is used to provide system pressure for manual traverse, elevation and cocking of the cannon. A foot pedal pump is used to fire the pum.

SPECIFICATIONS						
Vehicle system	Max slew s	peeds	Min tracking speeds			
	Azimuth	Elevation	Azimuth	Elevation		
	(°/s)	(°/s)	(mil/s)	(mil/s)		
Leopard 2	40	10	1.	1.		
Leopard 1	20	7	0.5	0.5		
TAM	20	7	0.5	0.5		
M48	20	7	0.5	0.5		
Luchs	60	40	0.4	0.4		
Marder 1	45	40	0.25	0.25		
VCTP	60	45	0.2	0.2		
Power supply	24 V DC vehicle system					

Status: In production. In service with Argentina, Germany, the Netherlands, Switzerland and other countries.

Manufacturer: Feinmechanische Werke Mainz (FWM) GmbH, Division Ordnance Systems, PO Box 2020, D-6500 Mainz 1, Federal Republic of Germany.

Telephone: (61 31) 698-0 Telex: 4187712 Fax: (61 31) 698-207



Leopard 1 MBT gun control equipment power package from FWM

INTERNATIONAL

GE Aerospace/Elbit Block III Demonstration Electric Gun and Turret Drive (EGTD)

Development/Description

The Defense Systems Department of the American GE Aerospace company has teamed with Elbit Computers Ltd of Israel to develop and design a demonstration EGTD system for evaluation as part of the US Army Block III MBT development programme.

Sponsored by the US Army's Armament Research, Development and Engineering Center (ARDEC) the EGTD system's performance will be evaluated in an M1 Abrams MBT fitted with a simulated Advanced Tank Cannon System (ATCS). The ATCS will have significantly higher inertia and elevation unbalance than current tank weapons.

The EGTD is based on the application of 270 V brushless motors. The standard voltage for Vectronics is 270 V DC, and this may also be used for autoloader power. System components comprise:

- (a) an elevation ball screw brushless motor drive with an internal pneumatic equilibrator to compensate for gun unbalance. A manual back-up drive and electric brake are included
- (b) a traverse gear drive powered by a brushless motor with a two-speed back-up manual drive and a solenoid operated brake
- (c) power amplifier units for each axis containing the electronics required to provide pulse width modulated power to the motors
- (d) a systems electronics unit containing low level control and logic circuit components
- (e) an assembly to store energy generated during deceleration
- (f) interconnecting plug-in cable set
- (g) standard M1 gyros and hand controls.

SPECIFICATIONS

INPUT POWER STABILISATION ERROR (1 sigma)

WEIGHT AND SPACE LOADS

Inertia (SL-ft²) Unbalance (ft-lb) 270 V DC

less than >0.5 mrad bump and figure

eight courses

consistent with M1A1 turret configuration

40 000 (traverse); 4700 (elevation) 10 000 (traverse); 13 000 (elevation) Status: Development.

Manufacturer: Enquiries to Electric Turret Drive Programs, Defense Systems Department, General Electrics Company, 100 Plastics Avenue, Pittsfield, Massachusetts 01201-3698, USA.

ISRAEL

Elbit Electrically Stabilised Weapon and Turret Drive System

Development/Description

The Elbit weapon and turret drive system is designed to be adaptable to a whole range of both new-build and retrofitted turrets such as the French AMX-series, American M-series, T-series and other tanks.

Being modular it can also be adapted for use with new and retrofitted armoured vehicles, automatic machine guns, anti-aircraft and anti-helicopter combat platforms and anti-tank missile launchers.

The main components include elevation and traverse drives with associated motors and power amplification units, commander and gunner hand control stations, or two axes gun gyro device, or system computer unit with an interface to the fire-control system.

SPECIFICATIONS

MAX TRAVERSE SPEED 36°/s TRAVERSE ACCELERATION 1 rad/s2 MIN TRAVERSE TRACKING SPEED 0.25 mil/s TRAVERSE STABILISATION 0.5-1 mil MAX ELEVATION SPEED 36°/s ELEVATION ACCELERATION 1 rad/s2 MIN ELEVATION TRACKING SPEED 0.25 mil/s **ELEVATION**

Status: Production as required. In service with unspecified countries

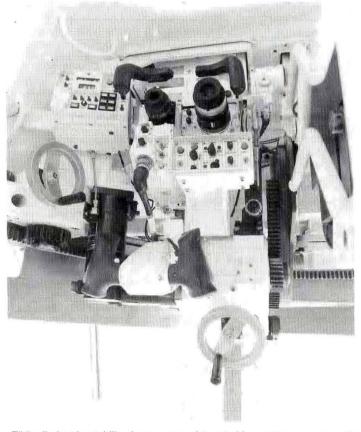
Manufacturer: Elbit Limited, Advanced Technology Centre, PO Box 539,

0.5-1 mil

Haifa 31053, Israel.

STABILISATION

Telephone: (04) 315315 Telex: 46774 Fax: (04) 550002



Elbit all-electric stabilised weapon and turret drive system components interfaced with a tank fire-control system

Elbit All-Electric Turret/Gun Drive and Stabilisation System

Development/Description

As part of the Merkava Mk 3 MBT programme Elbit has produced a modular all-electric turret/gun drive and stabilisation system. If required this can also be adapted to fit other heavy or medium turret armoured vehicles such as the AMX-30, M47, M48, M60 and Centurion MBTs. A smaller, more compact version is available for the SK 105, AMX-13, M41 and Scorpion light tanks.

The system features improved solid-state electronics with extremely fast response times, power and stabilised modes of operation and full manual back-up capability in both elevation and traverse. It is designed to operate

with most advanced fire-control systems and provides smooth tracking at all turret speeds to significantly improve fire-on-the-move performance.

Safety is improved by the elimination of any flammable high pressure hydraulic oil as used in the more conventional gun stabilisation systems.

Various power configurations are available: 24 V, 115 V, 270 V with either Brush or Brushless technologies.

 ${\bf Status:}$ Production. In service with the Israeli Army (on Merkava Mk 3 MBT) and other unspecified countries.

Manufacturer: Elbit Ltd, Advanced Technology Centre, PO Box 539, Haifa 31053, Israel.

Telephone: (04) 315315 Telex: 46774 Fax: (04) 550002

SHL Turret System Upgrade Packages

Development/Description

As part of its Total Upgrading Programme for tanks, SHL offers both Turret Stabilisation System and Turret Power System options. The company's expertise in these areas is based on the design and integration work it carried out on power controls and stabilisation systems devised for several upgrade programmes undertaken for Western and former Soviet built tank models operated by the Israeli Armoured Corps and several foreign countries.

The concept is to first survey the customer's existing tanks and then follow it up by a rapid report which includes the various options available for a cost effective upgrade of the vehicle turrets.

If required a prototype can then be upgraded in the customer's own

country, with the participation of its engineers, in order to demonstrate the customer specified level of performance. Deliveries are then made in kit form from Israel to the country to allow local installation and integration of the system.

A typical package for a turret upgrade would consist of:

- (a) deck clearance valve
- (b) gun elevating mechanism
- (c) add-on stabilisation system
- (d) hydraulic valve
- (e) super elevating actuator
- (f) hydraulic power pack
- (g) gunner's control handle.

SHL also offer a Suspension System (qv) upgrade as part of the overall Total Upgrade Programme.

The range of turret upgrade equipment supplied for various vehicle types is shown in the table below.

Starting Year	76	78	80	82	84	86	88	90	Forecast
Equipment Type									
Hydraulic power pack	Mer						AMX		
Electrical turret controls									T-55
Gunner's control assembly	Mer						AMX		
Commander's control assembly				M48 M60				AMX	
Elevating mechanism	Mer	Cent		M48	M10	19	AMX	(
assembly				M60					
Elevating valve	Mer	Cent		M48				AMX	(
assembly				M60					
Traverse valve	Mer	Cent	t	M48			AM>	(
assembly				M60					

Starting Year	76	78	80	82	84	86	88	90	Forecast
Improved hydraulic valve assembly	Mer	Cent		M48 M60					
Automatic loader									M1A1
									M60

Vehicle key: Mer = Merkava, Cent = Centurion, AMX = AMX-30

Status: Production as required. In service with Israeli Defence Force and several unspecified countries.

Manufacturer: Servo Hydraulics Lod (SHL), PO Box 190, Lod 71101,

Israel.

Telephone: (972) 8 222780 Telex: 381520 SHLD IL Cable: ISRAELAVIA Fax: (972) 8 222792 Group 2, Group 3

NORWAY

NFT Electric Drive System for Gun Turrets

Development/Description

NFT are producing electric drive systems for light turrets of the 1500 kg class armed with 20 to 30 mm calibre cannon.

SPECIFICATIONS

CONTROL Traverse

max speed max acceleration speed

min acceleration speed Elevation

max speed max acceleration speed min acceleration speed POWER SUPPLY MAX POWER 60°/s >80°/s² 0.4 mrad/s 48°/s >240°/s²

0.4 mrad/s

24 V DC

1800 W

Status: Production as required. In service with unspecified countries.

Manufacturer: NFT, Manufacturing Division, PO Box 1003, N-3601 Kongsberg, Norway.

Telephone: (47 3) 73 82 50 Telex: 71491 vaap n Fax: (47 3) 73 85 86

SOUTH AFRICA

ESD Generic Brushless Low Voltage Gun Control Equipment

Development/Description

ESD has developed a range of generic gun control electronic units which may be applied in gun control systems ranging from light (20 mm calibre) up to heavy (140 mm calibre) catergories.

State-of-the-art technology is used to provide optimum packaging densities, and along with reduced component counts ensures that cost effective and reliable systems are produced. The gun drive electronics feature integrated control circuits based on high speed microprocessor architecture.

The drives are especially designed using a building-block appropriate for the control of brushless AC servo motors (permament magnet rotor-sychronous/3-phase motors) and utilise pulse-width modulation techniques to feed current to the respective motor phases via switch power bridge. Torque angle shifting and current limiting according to motor speed are implemented by the control circuits as is the electronic commutation.

The power bridges are MOSFET based and utilise devices capable of switching high currents with low voltage supported by advanced gate drive and output conditioning techniques, with device protection enhanced by snubber circuits incorporating flyback diodes. Input power is switched through by means of a power interface unit with a soft start mechanism. Input voltage range is from +18 V to +62 V DC.

Built-In Test Equipment (BITE) algorithms are processed by the microprocessor based control circuitry output diagnostic data to an intelligent Personal Computer (PC) based terminal by means of RS422 digital interface serial communications databus.

Additional data communications ports allow for interfacing to other subsystem components such as the trunnion position sensor (utilised during gun offset implementation) and a fire-control system. Logical interfacing circuitry is provided for the reading of limit switches, actuation signals and other subsystem component data. Other sensors such as crew hand controllers and a gun stabilisation sensor are read by means of analogue to digital interfaces.

The units are developed to the latest military design requirements and are of ruggerised design, offering American MIL-STD-810E environmental protection standards. Functionality or capability may be adapted by means

of module changes with minimal engineering effort and associated technical risk. The units may be designed into new servo systems or as a replacement electronic unit in upgrade programme. Modularity of the design also allows for high voltage, low current versions which may be applied in systems with high voltage power supplies such as anti-aircraft turret drives and naval weapons.

Status: Development ongoing. May be altered to suit clients specifications.

Manufacturer: ESD (Pty) Ltd, 42 James Crescent, PO Box 35, Halfway House 1685, Republic of South Africa.

Telephone: (27) 11 315 5555 Fax: (27) 11 805 3190



ESD generic gun control electronics unit

ESD M41 Gun Control System

Development/Description

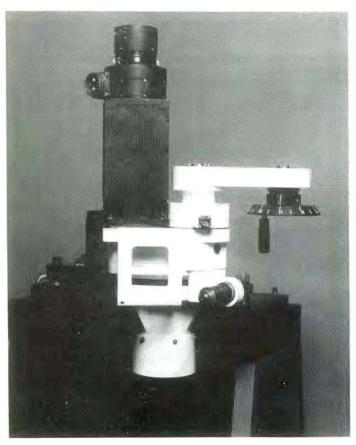
The ESD M41 electric low voltage gun control equipment was custom designed for the M41 light tank and by January 1993 the system had been installed, commissioned and successfully tested.

The system uses modern electronic design features to provide drop-in replacement control system with in-built low life cycle costs. The system has performance characteristics of slew speeds in excess of 40°/s and slow speed tracking of less than 0.25 mil/s. Acceleration and deceleration of better than 600 mil/s2 are attained. An interface is provided for integration with a fire-control system by means of a digital serial databus.

The main components of the system are its azimuth mechanism and elevation mechanism, together with all control electronics. It has hand controllers for both the gunner and commander as well as a status panel with gun stabilisation sensor as an option.

The components of the system are as follow:

(a) Azimuth mechanism - this utilises a planetary gear stage for minimal backlash and high stiffness. A secondary drive assembly provides a hand wheel for comfortable manual use by the gunner.



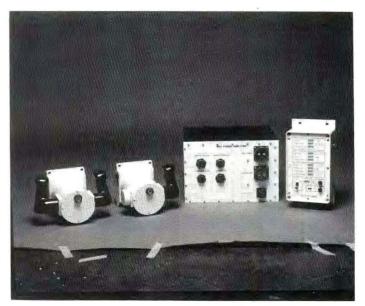
The azimuth mechanism employs a compact planetary reduction stage ensuring low backlash

- (b) Elevation mechanism this is a linear assembly which makes use of a roller screw and incorporates a secondary drive assembly with its hand wheel ergonomically again placed for easy use by the gunner.
- (c) Control electronics these are packaged into a single compact module which incorporates high speed microprocessor control for both axes. The power stage is MOSFET based and controls currents of up to 250 A at 24 V DC supply. Inputs from both the crew hand controllers and gun stabilisation sensor are processed within the system which ensures controlled output currents to both the azimuth and elevation motors.
- (d) Hand controllers the hand controllers for both the gunner and the commander are of rugged ergonomic design. They incorporate additional switches for other turret subsystems such as, for example, a laser rangefinder and weapon firing circuit. Both hand controllers share identical mechanics thereby achieving a cost effective modularity of design although the commander of the vehicle has only one control
- (e) Status Panel apart from housing the system power switch, the status panel provides the tank crew with full indications of system status and limit region status, both operationally and as a test facility.
- Gun stabilisation sensor this optional system incorporates two axis gyroscope with signal conditioning for simplified interfacing with the control electronics.

Status: Development complete. Production as required.

Manufacturer: ESD (Pty) Ltd, 42 James Crescent, PO Box 35, Halfway House 1685, Republic of South Africa.

Telephone: (27) 11 315 5555 Fax: (27) 11 805 3190



Control electronics

ESD Main Battle Tank (MBT) Gun Control System

Development/Description

ESD has developed the MBT Gun Control System for application in heavy turrets with over 33 000 kg/m² azimuth inertia and utilising main weapons with a minimum calibre of 105 mm.

The main components of the system are:

- (a) Control Electronics Module this is derived from the ESD range of low voltage brushless motor generic systems and features MOSFET based power stages with both azimuth and elevation electronics packaged into a single compact module. Microprocessor control is implemented for both axes, allowing for simple reprogramming of the control algorithms when installed into different turret types.
- (b) Azimuth Mechanism this is of a planetary design with a mounting bearing incorporating a preload system so as to optimise system stiffness. A handwheel is provided to allow comfortable manual operation of the system by the gunner. A slip-clutch prevents system damage in the event of main gun barrel fouling. The pinnion is crowned in order to optimise turret ring-gear life.
- (c) Elevation Mechanism this utilises a linear actuator (roller screw) and is underslung beneath the main weapon for enhanced turret space utilisation. Precision preloaded pivot mountings result in enhanced stiffness and zero backlash. An ergonomically positioned handwheel is provided for manual operation by the gunner.
- (d) Handcontrollers these are ergonomically designed according to a modular approach and result in the gunner's and commander's designs being similar and in sharing components. Interfaces are incorporated for the other turret subsystems which require switches on the hand controllers including, for example, the laser rangefinder and the main or coaxial machine gun firing circuits.
- (e) Trunnion Positioning Sensor this incorporates the elevation limit switches and may be set up to suit the elevation reach of any MBT. When the gun control system is coupled to a fire-control system, the trunnion position sensor houses a fine angular position sensor that is used during the offset implementation of the main gun.
- Gun stabilisation sensor this stabilises the gun control system and results in precision two axis stabilisation of the main armament.

The performance of a modern MBT turret fitted with the Gun System and with traverse and elevation inertias of 44 000 kg/m² and 4000 kg/m² respectively (ie equivalent to such MBTs as the Leopard 2, Challenger 2 and the M1A1 Abrams) is given in the table below:

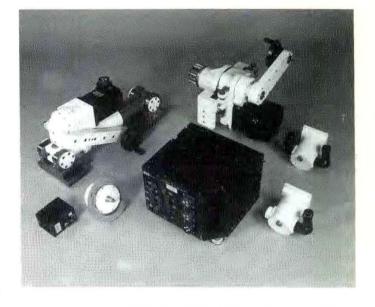
Function Traverse Elevation Acceleration 0.6 rad/s2 0.9 rad/s2 Max speed 600 mil/s 400 mil/s Min speed 0.1 mil/s 0.1 mil/s

Status: Development complete. Ready for production.

Manufacturer: ESD (Pty) Ltd, 42 James Crescent, PO Box 35, Halfway

House 1685, Republic of South Africa.

Telephone: (27) 11 315 5555 Fax: (27) 11 805 3190



Main components of the ESD MBT Gun Control System

SWITZERLAND

SIG Electrohydraulic Gun Control System

Development/Description

SIG has developed a range of electrohydraulic gun control systems suitable for use in Infantry Fighting Vehicles, MBTs, self-propelled anti-aircraft gun systems and self-propelled howitzers. They can be fitted either as new or as a retrofit package

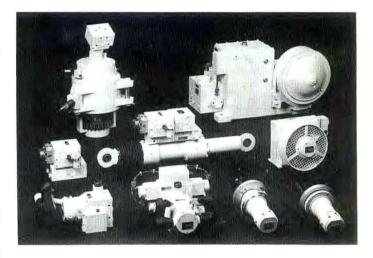
Typically for a 105 to 120 mm gun equipped MBT, a SIG electrohydraulic gun control system comprises the following components:

- elevation and traverse drive with gearbox
- 2) gunner's and commander's controller units
- 3) emergency hand pumps
- 4) hydraulic power unit with accumulator
- radiator.

Status: Production. Over 2000 electrohydraulic gun aiming and stabilisation systems are in service with a number of armies (on vehicles such as the Pz 68, Leopard 1 and OF-40).

Manufacturer: SIG-Swiss Industrial Company, Power Transmission Control Division, CH-8212 Neuhausen Rheinfalls, Switzerland.

Telephone: (053) 21 61 11 Telex: 896021 sig ch Fax: (053) 21 66 09



Main components for electrohydraulic gun aiming and stabilisation system for MBT armed with 105 mm to 120 mm gun

SIG T-54/55 Gun Control Retrofit Kit

Development/Description

As part of the various Egyptian Army's upgrade programmes for its T-54/55 MBT fleet the SIG Swiss Industrial Company joined with Jung Jungenthal GmbH and several other international companies to provide one such package. SIG's contribution was the development of an electromechanical turret drive and weapon aiming/stabilisation kit which can be used either with the original 100 mm D-10 series tank gun or a replacement Western model 105 mm rifled gun.

Status: Production as required.

Manufacturer: SIG-Swiss Industrial Company, Power Transmission Control Division, CH-8212 Neuhausen Rheinfalls, Switzerland.

Telephone: (053) 21 61 11 Telex: 896021 sig ch Fax: (053) 21 66 09

SIG Brushless 24 V DC Electrical Gun Control and Stabilisation System

Development/Description

SIG has developed a brushless electrical gun control and stabilisation system for use with turrets varying in type from relatively simple machine gun carrying models up to the 120 mm gun armed models of MBTs. It can be fitted either as new or as a retrofit package.

The system comprises the following basic components:

1) A high performance 24 V brushless motor with an outer steel-core wound stator. The rotor uses high energy Samarium/Cobalt (Sm/Co) magnets to provide the performance required at minimum size, weight and rotor inertia.

Various motor models, with peak torque between 2.2 and 90 Nm and 0.5 to 60 Nm RMS torque respectively, are available. The maximum speed is up to 10 400 rpm and the maximum to minimum speed ratio approximately 10 000:1

- Two-stage reduction gearbox with modern tooth wheel technology and adjustable backlash compensation and maximal stiffness. The hand crank is completely disconnected from the load shaft and can be activated in minimal time
- Servo-electronic control units which accept analogue command signals to provide a highly accurate closed-loop velocity control capability. Appropriate servo compensation is included in the feedback loop with the implemented gyro signals leading to a stabilised system.

The motor current logic circuitry is incorporated into the controller and includes pulse width modulation, electronic commutation with speed controlled torque angle shifting and current limiting.

A Built-In Test Equipment (BITE) facility simplifies the maintenance.

An electronic power system with six bipolar transistors and associated flyback diodes which provide, depending upon the angular position required. the power switching of the current to the appropriate motor phases. The switches are operated by signals from the digital logic circuitry routed through the base drive circuits.

Output monitor signals are provided for the actuator position and motor current with the power stage operating to all four quadrants. The deceleration energy is fed back to the 24 V DC batteries. No external ventilation is required because of the low heat dissipation of the power stage.

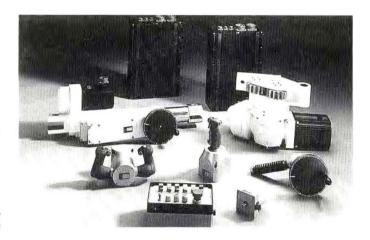
5) Ergonometrically designed one (commander's) and two (gunner's) hand-operated controllers generate the DC output signals. Up to four independent function switches can be fitted.

Status: Development complete. Ready for production.

Manufacturer: SIG-Swiss Industrial Company, Power Transmission Control Division, CH-8212 Neuhausen Rheinfalls, Switzerland.

Telephone: (053) 21 61 11 Telex: 896021 sig ch Fax: (053) 21 66 09

Components for the SIG 24 V brushless electrical turret drive system include gunner's and commander's controller, control and power electronics



SIG All-Electric Turret Drive and Gun Laying System with digital AC Servos (dACs) and Brushless Technology

Development/Description

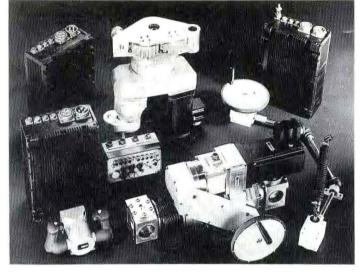
The modular designed digital AC Servos (dACs) drive-system for weapon aiming and stabilisation drives is available with different software configurations for the implemented control loops, various electric motors and several sizes of mechanical rotary and linear gearboxes. The system can be fitted as part of a new build system or as a retrofit kit. Its normal mode of operation is as a closed speed loop control with separated power and signal electronics.

The Axis Controller (AXCON) signal electronics module interfaces all the signals within the vehicle and generates the signals to control the power switches. All signals are processed by a microprocessor with an extreme low instruction cycle time. Signals from the control handles, stabilisation and interface electronics for both axes are in-routed through one housing or integrated in the fire-control computer.

The power electronics modules Drive Unit (DRU) has MOS-FET power transistors with control currents of up to 300 A at 24 V DC supply. The electronic hardware for each axis is contained in separate boxes. The brushless AC servometers have rotors with low inertia load to provide high acceleration. The coils are placed directly in the motor housings to reduce heat build up.

The gears for the elevation and traverse drives are of a modular water and dustproof design. Two-stage gears - first stage spur gear and second stage planetary gear - are available for the traverse drive with an externally adjustable zero backlash. The elevation drive has a standard one-stage spur gear with rotary input and linear output via a planetary screw drive. Optional elevation drives are available with ring gear segments and rotary drives.

One- and two-stage waterproofed control handles for simultaneous two axis control and fitted with up to four integral switches and a signal amplifier with optional digital or analogue output are also available.



Main components of the SIG all-electric drive and gun laying system with digital AC servos (dACs) and brushless technology

Status: Ready for production.

Manufacturer: SIG-Swiss Industrial Company, Power Transmission Control Division, CH-8212 Neuhausen Rheinfalls, Switzerland.

Telephone: (053) 21 61 11 Telex: 896021 sig ch Fax: (053) 21 66 09

SIG Universal Control Handles

Development/Description

The SIG universal control handles have been designed to act as multifunctional motion handles for simultaneous electrical or electrohydraulic control of two axes in systems such as gunnery control units.

As a result of a modular construction approach various versions with differing additional functions and an option for final stabilisation are available as single or two-hand handles. Each of these models can be fitted with up to four independent switches for the different functions.

Positioning and aligning in the two axes is implemented by deflecting the control handle towards the desired direction. The speed of alignment is related to the degree of deflexion (max +24°). The home (or zero) position is centred by spring action. This self-centring action is damped. Both the zero point and maximum deflexion can be set from the outside.

Status: Production. In service with a number of undisclosed countries.

Manufacturer: SIG-Swiss Industrial Company, Power Transmission Control Division, CH-8212 Neuhausen Rheinfalls, Switzerland.

Telephone: (053) 21 61 11 Telex: 896021 sig ch Fax: (053) 21 66 09

UNITED KINGDOM

Horstman Defence Systems Gun Control Equipment

Development/Description

In addition to designing and manufacturing suspension and engine systems, details of which are given in earlier sections, Horstman Defence Systems also manufacture a number of gun control subsystems and brief details of these are given below.

Warrior cupola gearbox

This was designed by Horstman Defence Systems for the commander's

cupola of both the GKN Defence Warrior Repair and Recovery Vehicle and the Warrior Combat Repair Vehicle, both of which are now in service with the British Army. The traverse gearbox incorporates a patented irreversible drive mechanism and will readily adapt to other vehicle applications.

Challenger 1 traverse and elevation gearbox

Horstman Defence Systems manufacture both the traverse and elevation gearboxes for the Challenger 1 and Chieftain MBTs.

The elevation gearbox incorporates a rack and pinion elevating mechanism attached to the gun cradle. The prime mover is an electric motor with emergency back-up via a hand wheel. The drive train incorporates an overload clutch.

incorporating an overload clutch and emergency back-up hand drive. Challenger 2 traverse and elevation gearbox systems

Horstman Defence Systems have developed the elevation gear system for the Challenger 2 MBT, nine prototypes of which have been built by Vickers Defence Systems under contract to the British Ministry of Defence.

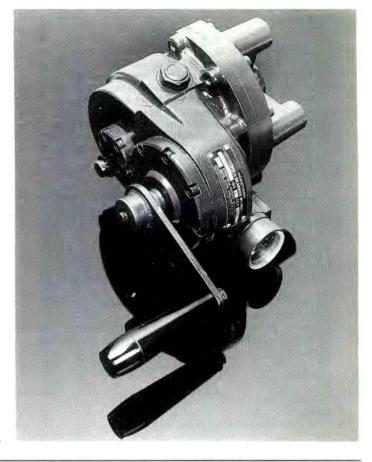
The traverse gearbox is an electrically driven reduction system

Status: Production as required.

Manufacturer: Horstman Defence Systems Limited, Locksbrook Road,

Bath BA1 3EX, UK

Telephone: (0225) 423111 Telex: 444363 Fax: (0225) 444357



Horstman Defence Systems Warrior cupola gearbox

Marconi MOGUL Modular Gun Laying System

Development/Description

The Marconi MOGUL modular gun laying system is designed for use with new build guns and as a retrofit package kit. It allows for the following system configurations:

1) MOGUL plane conversion. This is used primarily with towed guns but can be supplied for self-propelled guns where increased gun laying accuracy and speed are required with the use of traditional optical sighting

The normal indirect fire sight is rigidly mounted to the gun and fitted with traverse and elevation decoders. A sensor then measures the trunnion tilt and another the gun elevation.

The target azimuth and elevation data is entered into a Display and Processing Unit (DPU) either automatically or through the integral keyboard. The DPU reads the encoder and sensor data to calculate and display the gun azimuth and elevation errors which result from the difference between the gun's current point of aim and the target point of aim.

The gun laying exercise would now be reduced to the simple process of traversing and elevating the gun until the error displays on the DPU read zero. Changes in weapon attitude during an action are automatically updated by the DPU to maintain a constant and accurate lay

The DPU software also enables storage for preplanned target data and crest clearance information to facilitate rapid target switching.

2) MOGUL auto-orientation. This is a more cost effective fit to selfpropelled guns than the MOGUL plane conversion.

An inertial reference unit is fitted to the gun trunnion to provide a direct measurement of the gun azimuth and elevation within seconds of arriving at the gun position.

Target data can be entered manually or automatically into the DPU where it is combined with the gun elevation and azimuth figures derived from the inertial reference unit, to produce and display the difference between the current point of aim and the target point of aim. The gun is then manually traversed and elevated until the error displays read zero

Preplanned target data and crest clearance information can also be selected on the DPU.

3) MOGUL auto-lay. This includes auto-orientation and full automation of the gun laying procedure. All the vehicle commander has to do is press the 'lay' button on his control panel for the gun to move automatically to the correct lay position with no further manual intervention.

During burst firing the lay is maintained automatically between rounds for use with auto-load and rapid ammunition handling systems

MOGUL also allows for system expansions so that the full package together with a modern fire-control system will provide a semi-autonomous artillery weapon. If an inertial navigation capability is added the system becomes a fully independent autonomous artillery weapon.

The full autonomous artillery system including MOGUL will typically contain the following subsystems:

- i) electronics control unit
- ii) gunner's control unit
- iii) commander's control unit
- iv) MOGUL DPU unit with associated systems
- v) hydraulic filter and interface unit
- vi) inertial platform for MOGUL DPU parameters
- vii) hand controllers
- viii) emergency safety override buttons
- ix) optional shell position sensor to confirm that the shell is correctly rammed to avoid fallback
- x) optional gun tube temperature sensor to monitor the approach of round cook-off conditions
- xi) Marcal, 5° horizontal 10° vertical beam, Doppler muzzle velocity radar measuring head which is an on-gun system measuring the velocity of every round fired, stores the data and produces a statistical basis for gun calibration, thus offering a more rapid and accurate method of continuously correcting variables that affect the accuracy of firing, such as gun wear and meteorological conditions.

SPECIFICATIONS (when fitted to an M109 self-propelled gun utilising the existing fire-control system)

TYPICAL TRAVERSE VELOCITY	250 mil/s
TYPICAL ELEVATION	
VELOCITY	250 mil/s
OVERALL ACCURACY	0.5 mil pointing error in azimuth and elevation with respect to the inertial reference
TYPICAL TIME TO CLEAR 800 MILS AND SETTLE IN	
ELEVATION	10 s
TYPICAL TIME TO CLEAR	
3200 MILS AND SETTLE IN	
TRAVERSE	30 s
TYPICAL REDUCTION IN	
DEPLOYMENT TIME	50% over conventional methods

Status: Ready for production. Trialled on a M109A1 155 mm self-propelled howitzer in the UK and Germany

Manufacturer: Marconi Radar and Control Systems Limited, New Parks, Leicester LE3 1UF, UK.

Telephone: (0533) 871481 Telex: 34551 Fax: (0533) 871746

Marconi GCE 628 Gun Control and Stabilisation Equipment

Development/Description

The GCE 628 solid-state all-electric Gun Control and Stabilisation system has been designed, as a private venture, by Marconi Radar and Control Systems for use on modern MBTs and was adopted for use with the Vickers Valiant and Chieftain 900 MBTs, neither of which entered production.

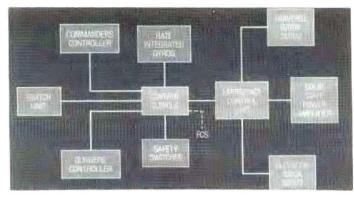
More recently it has been installed on the Vickers Mk 7 MBT, FMC/Vickers Mk 5 battle tank, ENGESA Osorio MBT and retrofitted to former Soviet T-series MBTs. It is however suitable for retrofit to other MBTs such as the Centurion, Chieftain, AMX-30, M48 and M60 among others

The main components of the GCE 628 are:

- 1) central electronic cubicle, which is interfaced to the fire-control system and receives the ballistic offset and target rate information
- 2) vehicle commander's hand controller, which provides an override capability to the electronic cubicle
 - 3) gunner's hand controller
 - 4) gunner's switch unit
 - turret safety, traverse safety and limit switches
- 6) sensor package with turret tachometer and individual turret, gun and hull avros
 - 7) emergency control unit with elevation and traverse servo motors
 - 8) solid-state power amplifier.

Depending on which fire-control system and sight assembly the GCE 628 is integrated with, the following modes of operation are possible:

- i) stabilised
- ii) non-stabilised
- iii) travelling
- iv) emergency
- v) coincidence firing
- vi) firing-on-the-move
- vii) moving-to-the-load position after firing.



Block diagram of Marconi Radar and Control Systems GCE 628 electric gun control and stabilisation system for MBTs

SPECIFICATIONS

Note: based on 16 000 kg turret with an inertia of 34 000 kg/m²

MAX TRAVERSE SPEED >650 mils/s TRAVERSE ACCELERATION >1000 mils/s TRAVERSE DECELERATION >1000 mils/s2 MIN TRAVERSE TRACKING

SPEED <0.25 mils/s MAX ELEVATION SPEED > 200 mils/s

MAX INSTANTANEOUS HULL **ACCELERATION** >2500 mils/s2

Status: Ready for production.

Manufacturer: Marconi Radar and Control Systems Limited, New Parks,

Leicester LE3 1UF, UK.

Telephone: (0533) 871481 Telex: 34551 Fax: (0533) 871746

Marconi PD700 Light Armoured Vehicle Dual Axis Power Drive System

Development/Description

The modular PD700 dual axis power drive has been designed as a private venture by Marconi Radar and Control Systems. It was to be used as a retrofit kit and for new build light armoured vehicle turrets with a total weight of 3000 kg and equipped with weapons ranging in calibre from 20 mm up to 90 mm.

The system has been trialled extensively on vehicles such as the tracked Scorpion (with both 76 mm and 90 mm turrets) and the wheeled ENGESA EE-9 Cascavel and on the Cockerill 90 mm turret system.

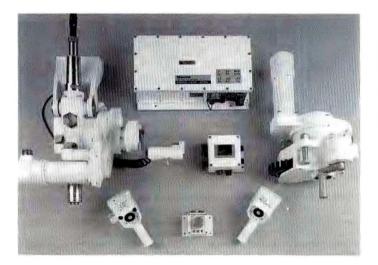
In June 1988 it was selected by Venezuela to be installed on its 80 Alvis Scorpion CVR(T) vehicles armed with a 90 mm gun and it has also been installed on the 90 mm Alvis Scorpion vehicles delivered to Togo.

The main components are:

- 1) traverse gearbox
- 2) elevation gearbox
- 3) gunner's hand controller
- commander's hand controller
- 5) electronics control cubicle
- 6) turret safety switch, traverse limit switch and driver's safety switch.

The PD700 gives the vehicle crew complete two axis power control of the gun and turret with accurate response over a wide speed range from slow tracking at better than 0.5 mil/s to fast slew at 400 mil/s, which corresponds to a full 360° traverse in 16 seconds. Higher speeds are available dependent on customer requirement. The controlled acceleration/deceleration rates are 500 mil/s2. A 90° target switch in traverse takes only five seconds including the time required for settling.

It can be used on slopes up to 30° in inclination with only slight degradation of performance



Components of The Marconi PD700 Light Armoured Vehicle Dual Axis Power Drive System

Status: Production as required. In service with Togo and Venezuela.

Manufacturer: Marconi Radar and Control Systems Limited, New Parks, Leicester LE3 1UF, UK.

Telephone: (0533) 871481 Telex: 34551 Fax: (0533) 871746

United Scientific Gun Control Equipment for T-series MBTs

Development/Description

The principle components of the electrohydraulic gun control systems for the T-54, T-55, T-62 and Type 59 MBTs can be supplied as direct replacements for existing items or as a complete upgrade package for the T-54 and Type 59 to bring them up to the gun control standard of the T-55. The complete component listing is:

UNIT	T-54	T-55	Type 59	T-62
amplidyne generator	GC1000	GC1000	GC1000	GC9000
turret traversing motor	GC2000	GC2000	_	GC10000
hydraulic booster	GC3000	GC3000	GC3000	GC15000
alternator and				
regulator	GC4000	GC4000	GC4000	GC4000
gun turret				
controller	GC5000	GC5000	GC5000	GC5000
electronic amplifier	GC6000	GC6000	GC6000	GC6000
gyro unit	GC7000	GC7000	GC7000	GC11000
distribution unit	_	-	_	GC8000
actuating cylinder	_	_	_	GC12000
cartridge extraction motor	_	_	_	GC13000

The individual components are:

- a) amplidyne generator, this is a fast reacting rotary amplifier that is capable of converting low power command signals to high power output voltage and current for the purposes of controlling the speed and rotation of the turret traversing motor
- b) alternator and regulator which generates a 40 V, 400 Hz 3-phase stabilised supply for energising the gyro rotors, gyro sensory (rotary) transformers and amplifier power transformers
- turret traversing motor which, using the control signals from the amplidyne, traverses the turret in either direction as directed
- d) hydraulic booster which generates a fluid pressure, it also converts electrical control signals to mechanical control of pressure and direction of fluid flow to the hydraulic actuating cylinder for the purpose of elevating and depressing the gun
- e) gun turret controller which provides the means for the gunner to indicate mechanical action, this is then converted to electrical signals controlling both the speed and direction of movement of the gun in elevation and azimuth
- f) amplifier which accepts the low power receiver from the gyrostabiliser and amplifies them into high power signals for directing the speed, the traverse motor and hydraulic pump

- g) gyro unit which maintains the main and coaxial armament in the assigned attitude when the tank is in motion irrespective of the induced vehicle movements as it traverses the terrain
- h) distribution unit, this is used on the T-62 to control and protect the power levels assigned to all the elements of the stabiliser system and the switching of signals between stabilised and non-stabilised modes
- i) actuating cylinder, used on the T-62 to elevate and depress the 115 mm gun in a defined position
- j) cartridge extract motor which is used on the T-62 and is actuated by the gun recoil mechanism on firing. This opens the rear hatch on the turret so the 115 mm cartridge case is not only extracted from the breech but also ejected from the turret.

Status: Production as required. In service with unspecified countries.

Manufacturer: United Scientific Instruments Limited, Unit 5, Quinn Close, Manor Park, Whitley, Coventry CV3 4LH, UK

Telephone: (0203) 539299 Telex: 31332 Fax: (0203) 539281/539290

SPECIFICATIONS Unit	Weight	Length	Width	Height	Diameter
amplidyne generator	(kg) 38.5	(mm) 500	(mm) 170	(mm) 240	(mm) n/a
alternator and regulator	n/avail	245	150	195	n/a
turret traversing motor	14.1	240	n/a	n/a	138
amplifier	9	450	250	145	n/a
gun/turret controller	10.25	186	180	223	n/a
gyro unit	24	270	273	185	n/a
distribution unit	9	282	230	150	n/a
actuating cylinder	n/avail	623.5	140	172	n/a
cartridge extract motor	2	1300	n/a	n/a	750

UNITED STATES OF AMERICA

Cadillac Gage Textron Turret Power Control Systems

Development/Description

Cadillac Gage Textron constant pressure electrohydraulic power controls are designed to provide a totally self-contained turret drive system.

They have been chosen as standard fit for the Type 88, Stingray, Merkava, Leopard 2, Leopard 1, M60A1, M109, AAVP7, and the Cadillac Gage Textron Commando V-150/300/600 wheeled vehicle series.

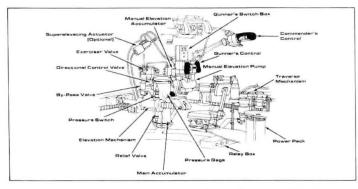
For the AIFV, M41, M42, M47, M48, M60, AMX-30, Centurion, Stingray and T-series armoured vehicles, retrofit kits are available to upgrade their turret control capabilities.

Both the new build and retrofit systems are fully compatible with the Cadillac Gage Textron Weapon/Turret Stabilisation Systems (qv) and they can be procured together to produce a complete turret upgrade package.

Typical turret power control system components include the following:

- gunner's control box
- commander's control handle
- 3) gunner's control handle
- 4) traverse mechanism system
- 5) power supply
- 6) main accumulator
- 7) elevation mechanism assembly
- 8) recoil exerciser valve
- 9) super elevating actuator unit.

An electromechanical weapon/turret power control system is also available for the two-man turrets of the types fitted to the Cadillac Gage Textron V-series armoured fighting vehicles.



Cadillac Gage Textron turret modernisation package for M41 light tank armed with 76 mm gun

SPECIFICATIONS (for a full turret modernisation with power control and stabilisation systems)

Vehicle	Minimum turret slew (°/s)				Stabilised accuracy (mil)	
	azim	elev	azim	elev	azim	elev
Centurion	25	30	0.5	0.5	1.0	0.5
T-series	30	35	0.25	0.25	1.0	0.5
M48	25	30	0.5	0.5	1.0	0.5
M41	40	40	0.3	0.3	n/avail	n/avail
M42	90	90	0.5	0.5	n/avail	n/avail
POWER SI	JPPLY 24	±6 V DC v	ehicle syst	tem		

SPECIFICATIONS (for a full electromechanical system on a V-series AFV 25 mm turret)

MIN TURRET SLEW	
azimuth	60°/s
elevation	60°/s
TURRET TRACKING	
azimuth	0.1 mil/s
elevation	0.1 mil/s
MANUAL RESPONSE	
azimuth	10 mils/rev
elevation	10 mils/rev
STABILISED ACCURACY	
azimuth	0.5 mils
elevation	0.5 mils

Status: In production. In service with the US armed forces and many other unspecified countries. A production listing of the Cadillac Gage Textron weapon/turret power control and stabilisation systems includes the following data:

Vehicle	Power controls	Stabilisation	Quantity
M47	yes	no	2000
M48	yes	yes	9000+
M60A1/3	yes	no	10 000+
M60A2	yes	yes	580
M1 series	yes	yes	7000+
Leopard 1	yes	yes	3200
Leopard 2	yes	yes	3000 +
Marder 1 ICV	yes	no	2000
Centurion	yes	yes	300
Other MBT	no	yes	350
M114	yes	no	1200

374 WEAPON CONTROL AND STABILISATION SYSTEMS / USA

Vehicle	Power controls	Stabilisation	Quantity
M109	yes	no	2000+
AAV7	yes	no	1250
M42	yes	no	250
AIFV	yes	no	1000+
Commando	yes	no	2000+

Manufacturer: Cadillac Gage Textron, Control Systems Marketing, PO Box 1027, Warren, Michigan 48090, USA.

Telephone: (313) 777 7100 Telex: 200707 Fax: (313) 776 9731

Cadillac Gage Textron Weapon/Turret Stabilisation Systems

Development/Description

The Cadillac Gage Textron turret/weapon stabilisation system is designed to interface with all types of modern fire-control systems and isolate the gun platform from the disorientating effects of the vehicle pitch, roll and yaw.

It has been chosen as standard fit for many new build MBTs including M1/M1A1/M1A2 Abrams, Merkava (manufactured under licence by SHL - Servo Hydraulic Lod) and the German Leopard 1 and Leopard 2 MBTs (made by FWM (qv)).

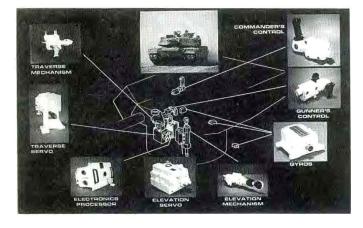
It can also be used to retrofit previously unstabilised vehicles and upgrade others through the use of a self-contained modernisation kit.

Such kits are already available for the Centurion, T-series, AMX-30, M41, M48 and M60 tanks, M109 self-propelled gun and the FMC Armored Infantry Fighting Vehicle.

Both the new build and retrofit systems are fully compatible with the Cadillac Gage Textron Power Control equipment.

System components for the M1 Abrams series include:

- 1) electronic processor unit
- 2) traverse mechanism system
- 3) traverse servo
- 4) elevation mechanism system
- 5) elevation servo
- 6) turret, hull and weapon gyro sensors



Cadillac Gage Textron gun/turret stabilisation system for M1/M1A1 MBT showing position of main components

- 7) commander's control handle
- 8) gunner's control handle.

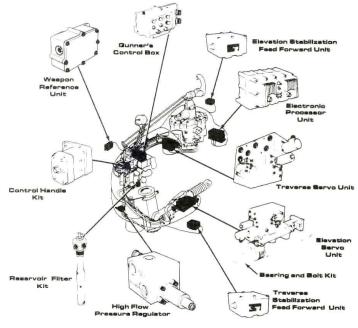
The other systems have comparable component inventories.

In 1988 electromechanical stabilisation system prototypes were produced for the M1A1 Abrams as well as for the LAV - Air Defense gun/missile turret. Production systems are available for the two-man turrets of the types fitted to the Cadillac Gage Textron V-series armoured fighting vehicles.

Status: In production. In service with the United States armed forces and many other countries.

Manufacturer: Cadillac Gage Textron, Control Systems Marketing, PO Box 1027, Warren, Michigan 48090, USA.

Telephone: (313) 777 7100 Telex: 200707 Fax: (313) 776 9731



Typical Cadillac Gage Textron Weapon/Turret Retrofit Stabilisation System for an MBT

GE Aerospace All-Electric Stabilised Weapon Control Systems

Development/Description

GE Aerospace has been a producer of indigenously developed turret drives since 1964. They are currently producing the all-electric stabilised servo-controlled drive systems for the M2/M3 Bradley family and the Avenger Pedestal-Mounted Stinger which uses an adaption of the Bradley system. Other applications include the Komatsu Type 87 wheeled reconnaissance and patrol vehicle, GE LAV-Air Defense Vehicle and as a retrofit package for various armoured vehicle types.

The M2/M3 Bradley all-electric stabilised servo-controlled turret, gun and missile drive system includes the following components:

- (1) power and manual traverse and gun elevation drives
- (2) TOW missile launcher unit lift and elevation drives
- (3) Digital Electronic Control Assembly (DECA) and power function assembly with Advanced Built-In Test (ABIT)
- (4) gunner's and commander's hand controllers
- (5) interconnecting cable set.

Status: M2/M3 Bradley turret, gun and missile stabilised drive system in series production with over 7000 built. In service with the US Army. Avenger PMS system in production. In service with the US Army. Type 87 in production. In service with the Japanese Ground Self-Defence Force.

Manufacturer: GE Aerospace, Electric Turret Drive Programs, Defense Systems Department, 100 Plastics Avenue, Pittsfield, Massachusetts 01201, USA.

Telephone: (413) 494 6571



M3 Bradley Cavalry Fighting Vehicle has a General Electric designed and built stabilised weapon control system (Michael Green/US Army)

GE Aerospace Armored Gun System (AGS) All-**Electric Stabilised Turret Drive System**

Development/Description

The GE-AGS all-electric stabilised turret drive was designed for use on the US Army's AGS vehicle and has been field-tested in prototype form. The drive is derived from the company's M2/M3 Bradley weapon control system and comprises the following subsystems:

- (a) Digital Electronic Control Assembly (DECA)
- (b) turret azimuth drive
- (c) gun elevation drive
- (d) gunner's and commander's handstations
- (e) gun and turret gyro blocks.

The system has applications for both manned and unmanned AGS turret configurations and is capable of stabilised, powered and manual modes of operation. It can also be fitted with either analogue or digital interfaces. Advanced Built-in Test (ABIT) facilities are available as standard fit.

SPECIFICATIONS

SLEW RATE 1 rad/s 0.05 mil/s MIN TRACKING BATE STABILISED ACCURACY 0.5 mil CROSS-COUNTRY TIME-ON-TARGET 90%

Status: Prototype.

Manufacturer: GE Aerospace, Defense Systems Department, 100 Plastics

Avenue, Pittsfield, Massachusetts 01201, USA.

Telephone: (413) 494 6571

Alliant Techsystems MBT Turret 24 V Electrical **Drive System**

Development/Description

The Alliant Techsystems modular turret electrical drive system is designed for use in MBT turrets. It has three modes of operation:

- 1) laying-, stabilisation-/slaving
- 2) laying (with tacho alternator)
- 3) emergency, whereby the laying is performed manually by hand cranks. The main components of the system are:
- central electronic unit
- ii) elevation drive unit
- iii) traverse drive unit
- iv) turret gyro package
- v) weapon gyro package
- vi) control handle.

Optional functions include automatic drift compensation, integrated mechanical clamping of the gun in the loading position for an auto-loader and the use of a digital controller.

SPECIFICATIONS

TOTAL SYSTEM WEIGHT 300 kg MAX TRAVERSE SPEED 40°/s

MAX TRAVERSE TORQUE 15 000 Nm MIN TRAVERSE TRACKING SPEED 0.3 mil/s MAX ELEVATION SPEED 45°/s 10 000 Nm MAX ELEVATION TOROUE MIN FLEVATION

TRACKING SPEED 0.3 mil/s

POWER SUPPLY 24 V DC vehicle system

Status: Production as required. Alliant Techsystems electrical turret drive and stabilisation systems are known to be in service with the Netherlands (retrofitted to its Leopard 1 MBTs) and more recently it was announced that the Swiss Pz 68 105 mm armed MBTs were to be retrofitted with a new Honeywell (Germany) fire-control system produced under licence in Switzerland by Contraves.

Manufacturers: Alliant Techsystems, Honeywell Plaza, 2701 4th Avenue South, Minneapolis, Minnesota 55408, USA.

Telephone: (612) 870 5200 Telex: 910 5762692

Honeywell Regelsysteme GmbH, Aerospace and Defence, Honeywellstrasse, PO Box 1109, D-6457 Maintal 1, Federal Republic of Germany.

Telephone: (06181) 401 (1) Telex: 4184820

Alliant Techsystems Light Turret 24 V Electrical **Drive System**

Development/Description

The Alliant Techsystems light turret electrical drive system is designed for use with light tank turrets. It has three modes of operation:

- (1) laying and stabilisation-/slaving
- (2) laying (with alternator generator)
- (3) emergency hand cranking

The main components of the system are:

- (i) electronic unit
- (ii) gyro package
- (iii) azimuth drive
- (iv) programming unit (v) control handle
- (vi) elevation drive

Optional is an automatic drift function.

SPECIFICATIONS

TOTAL SYSTEM WEIGHT 180 kg MAX TRAVERSE SPEED 70°/s MIN TRAVERSE TRACKING SPEED 0.3 mil/s MAX TRAVERSE TORQUE 8500 Nm MAX ELEVATION SPEED 80°/s MIN ELEVATION TRACKING SPEED 0.3 mil/s MAX ELEVATION TORQUE 3500 Nm POWER SUPPLY 18-32 V DC

Status: Production as required. In service with a number of undisclosed

Manufacturers: Alliant Techsystems, Honeywell Plaza, 2701 4th Avenue South, Minneapolis, Minnesota 55408, USA Telephone: (612) 870 5200 Telex: 5762692

Honeywell Regelsysteme GmbH, Aerospace and Defense, Honeywellstrasse, PO Box 1109, D-6457 Maintal 1, Federal Republic of

Telephone: (06181) 401 (1) Telex: 4184820

Alliant Techsystems 24 V Electric Drive System for Lightweight Observation Cupolas

Development/Description

The Alliant Techsystems electric drive system for lightweight cupolas is used on MBT turrets and others, and has four modes of operation:

- (1) stabilisation
- (2) slaving
- (3) laying
- (4) emergency hand cranking.

The main components of the system are:

- (i) azimuth drive (ii) control handle
- (iii) electronic unit
- (iv) programming units
- (v) sensor system.

SPECIFICATIONS

TOTAL SYSTEM WEIGHT 50 kg MAX TRAVERSE SPEED 60°/s MIN TRAVERSE TRACKING 0.5 mil/s MAX TRAVERSE ACCELERATION

(at 50 m kg) 85°/s MAX TORQUE 450 Nm MAX AZIMUTH RANGE ±180°

POWER SUPPLY 18-32 V DC vehicle system

Status: Production as required. In service with numerous countries.

Manufacturers: Alliant Techsystems, Honeywell Plaza, 2701 4th Avenue South, Minneapolis, Minnesota 55408, USA. Telephone: (612) 870 5200 Telex: 910 5762692

Honeywell Regelsysteme GmbH, Aerospace and Defense, Honeywellstrasse, PO Box 1109, D-6457 Maintal 1, Federal Republic of Germany. Telephone: (06181) 401 (1) Telex: 4184820

AFV Fire-Control Systems

AUSTRIA

PHOTONIC FSC-530 Fire-Control System for Recoilless Guns

Development/Description

The FCS-530 is an optoelectronic system for anti-tank recoilless guns that allows effective engagements against both stationary and moving targets at typical ranges of up to 2000 m.

To achieve high first round hit probability at these ranges it is necessary to accurately determine:

(a) the target range (that is superelevation angle)

(b) the angle through which the target will move during the Time Of Flight

(TOF) of the projectile (that is the lead angle).

The former information is gained by an integral Nd-YAG Laser Rangefinder (LRF) and the 8-bit single-chip CMOS Built-in Ballistic Computer (BBC) then calculates the superelevation and lead angle figures from the measured target range. The lead angle is derived from the calculated TOF by observing the target's angular movement between firing the LRF, at which point the BBC starts counting the TOF, and the end of TOF which is indicated to the gunner by the BBC.

The FCS-530 is available in both daylight and day/night vision versions. In the latter case an add-on customer choice second or third generation 18 mm wafer type image intensifier system is used. The reticle pattern and information displays remain the same. The daylight version can be configured to the day/night vision configuration at the depot level.

SPECIFICATIONS

 $\begin{array}{ll} \text{DIMENSIONS} \\ \text{daylight version} & 305 \times 158 \times 99 \text{ mm} \\ \text{day/night version} & 305 \times 158 \times 189 \text{ mm} \end{array}$

WÉIGHTS
daylight version 4.5 kg
day/night version 6.5 kg

OPTICS daylight version

daylight version × 5 magnification, 11° field-of-view 4 magnification, 10° field-of-view NOWER SUPPLY 6-8 V rechargeable powerpack

Laser rangefinder

TYPE Nd-YAG
MEASURING RANGE 50-2000 m
RESOLUTION 5 m

Status: Production as required. In service with undisclosed countries.

Manufacturer: PHOTONIC Optische Gerate GmbH, Zeillergrasse 20-22,

A-1170 Vienna, Austria.

Telephone: (0) 222 46 56 91-0 Telex: 112863 PHOTO A

Fax: (0) 222 46 56 91/33

BELGIUM

SABCA ATLAS Family Advanced Tank Laser Fire Control Systems

Development/Description

The ATLAS family of tank laser fire-control systems comprises the following members:

- 1) ATLAS Mk 1 designed to fit Centurion MBTs with a SABCA analogue ballistic computer, modified M35E1 integrated day channel/night image intensifier channel/laser rangefinder gunner's sight, and various sensor/control units. This system was chosen in 1979 by Teledyne Continental Motors as part of its Centurion retrofit package for the Jordanian Army. Subsequently, 293 systems were delivered to Jordan
- 2) ATLAS Mk 2 designed to fit Centurion MBTs identical to the Mk 1 system but with an integrated gunner's thermal sight
- 3) ATLAS Mk 3 designed to fit M48/M60 MBTs identical to the Mk 1/2 systems in content
- 4) ATLAS Mk 4 designed to fit AMX-30 MBTs identical to the Mk 1/2 systems in content.

The main subsystems for an ATLAS system are:

a) an integrated gunner's day/night sight assembly with a × 8 magnification,
 7° field-of-view laser visual unit day sight operating with a 1.06 μm wavelength
 Nd-YAG laser rangefinder that has a working range of up to 9990 m, an

accuracy of ± 10 m and target resolution capacity of better than 30 m, and either a second generation image-intensifier sight with a $\times 7.1$ magnification or all-weather day-and-night thermal imaging infra-red system with \times 8 magnification, $5.1\times 12^\circ$ wide and $1.7\times 4^\circ$ narrow fields-of-view

- b) gunner's control unit with manual input parameter capability
- c) commander's control unit with ammunition selection capability
- d) ammunition selection unit
- e) digital fire-control computer with capacity for ballistic data on up to four separate ammunition types and machine gun ammunition. The computation range is up to 3990 m
- f) sensor package comprising automatic cant angle sensor, air temperature sensor, crosswind sensor, powder temperature and turret tachometer
- g) servo unit driving a graticule projection unit for the sight system and an output unit for the gun ballistic drive system.

The power supply to the system is the standard vehicle 24 ± 6 V DC supply.

Status: ATLAS Mk 1 production complete. In service with the Jordanian Army. ATLAS Mk 2/3/4, development complete ready for production. The Atlas Mk 4 has been demonstrated in Venezuela on an AMX-30 MBT.

Manufacturer: Société Anonyme Belge des Constructions Aéronautiques (SABCA), Electronics Department, 1470 Chaussée de Haecht, B-1130 Brussels, Belgium.

Telephone: (02) 246 25 11 Telex: 21237 Fax: (02) 216 15 70



Integrated day/night laser subsystem group of ATLAS Mk 3 fire-control system for M48/M60 series MBTs comprising modified M35E1 periscope and M118E1 mount, integrated sight system with laser visual unit, image intensifier or thermal imaging channel, graticule projector, output device and electronic boxes for the laser and sight control



Ballistic computer subsystem for ATLAS Mk 1 fire-control system for Centurion MBTs comprising analogue computer with control units, attitude, turret angular rate and ambient atmospheric condition sensors

BATTLE-PROVEN



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A member of the Reutech Group

SABCA Titan Family Tank Fire-Control Systems

Development/Description

The Titan family of fire-control systems has been developed for use in retrofitting T-54/T-55 and Type 59 MBTs. The members are the basic Titan Mk I, the Titan Mk II (with image intensifier night sight and integrated gunner's periscopic sight), the Titan Mk III (with thermal night sight and integrated gunner's periscopic sight) and the Titan Mk IV (with fully stabilised primary sight and an image intensifier or thermal imaging night sight).

The SABCA Titan Mk I has been adopted by the General Products Division of the American Teledyne Continental Motors as part of the trial Ramses II (formerly T-54E) upgrade kit for the Egyptian Army T-54 rebuild programme.

The system as applied to the Egyptian Ramses II retrofit with its 105 mm main gun comprises the following components:

1) gunner's telescopic day sight which incorporates:

- a) a CRT alphanumeric display and firing graticule with the original engraved ballistic graticule retained as a backup. The eyepiece CRT displays the firing graticule during the firing sequence as well as all the information needed to start up and operate the system. During the initialisation, instructions and data are displayed on the CRT detailing both the step-by-step operating procedures and basic parameter introduction or mode selection
- b) a British United Scientific Instruments TL-10T Nd-YAG laser rangefinder
- 2) gunner's periscopic passive image intensifier sight mechanically linked to the main gun and incorporating the same eyepiece CRT alphanumericgraphic display and graticule unit as the day sight
- 3) digital ballistic computer which processes the manual and automatic parameter inputs required to calculate the fire-control solution and outputs the data to either gunner's sight, by controlling the graticule position, or the gun control system
- sensor package which includes: an automatic crosswind, ambient air temperature and pressure sensor; cant angle sensor; rate tachometer; and muzzle reference collimator unit
 - 5) gunner's control unit
 - 6) laser electronics unit
 - 7) Cadillac Gage Textron turret control and weapon stabilisation system
 - 8) interconnecting cable set.
- The new fire-control system capability is such that, when compared to the M60A3 firing the same APFSDS rounds as used by the Egyptian Army, the T-54 Ramses II has demonstrated the following first-round hit probability improvements at 1500 m range:

Firing platform	Target	% Improvement over M60A3
stationary	stationary	6
stationary	moving	4
moving	stationary	108
moving	moving	73

The main subsystems of the Titan Mk IV version are:

- stabilised gunner's laser day/night periscopic sight system with:
 - a) 2-axis stabilised head mirror unit
- b) integrated laser rangefinder with associated laser electronics and control units
- c) integrated image intensifier sight or thermal imaging camera with associated electronics and display units
 - d) day sight elbow
 - 2) computer fire-control unit with:
 - a) digital ballistic computer
 - b) CRT interface
 - c) sensor package interface
 - d) power supply modules
 - e) cant angle sensor
 - 3) servo-electronics unit with:
 - a) azimuth and elevation servo electronics
 - b) gyro excitation
 - azimuth and elevation interfaces
 - d) tank interfaces
 - e) AC and DC power sources
 - gunner's control unit
 - 5) automatic ambient atmospheric sensor
 - 6) muzzle reference system with muzzle reference mirror unit
 - 7) gun resolver assembly
 - 8) interconnecting cable set.

Status: Development complete. Ready for production.

Manufacturer: Société Anonyme Belge des Constructions Aéronautiques (SABCA), Electronics Department, 1470 Chaussée de Haecht, B-1130 Brussels, Belgium.

Telephone: (02) 246 25 11 Telex: 21237 Fax: (02) 216 15 70



Components of SABCA Titan Mk I Fire Control System

SABCA Universal Tank Fire-Control System

Development/Description

The Universal Tank Fire-Control System (UTFCS) is equipped with a stabilised sight and is designed to provide a full shoot-on-the-move capability against both stationary and moving targets.

The main components of the system are:

- 1) an integrated gunner's periscope sight which includes:
- a) a 2-axis stabilised head mirror unit that constitutes the upper part of the sight and which projects above the turret roof
- b) a laser visual unit assembly which integrates the day channel for observation and aiming by the gunner with the Nd-YAG 1.06 μm wavelength laser rangefinder.

The day sight channel has a magnification of \times 8 and an 8° field-of-view. The laser rangefinder has an operating range of 200-9990 m, a range accuracy less than or equal to 15 m and a target resolution of 10 m.

- c) night sight unit which is fitted with either a second generation image intensifier tube elbow or a HgCdTe thermal imaging system elbow. The latter has two magnification capabilities of \times 8 and \times 3.4 with 5.1 \times 12° wide and 1.7 \times 4° narrow fields-of-view. The elbows are fully interchangeable
 - 2) laser electronic unit
- 3) 16-bit digital ballistic computer and system electronic unit which calculates the super-elevation and lead angles after taking into account all the manual and automatic fire-control parameter inputs and correcting for tank/target motion. The design of the system allows for the acceptance of a CO₂ laser rangefinder and the following growth capabilities:
 - a) tracking of ATGWs
 - b) anti-helicopter fire-control missions
 - c) target auto-track mode
 - d) advanced status display
- 4) commander's control unit with computer controlled displays for text and numeric information, and manual parameter input switches for altitude, air temperature, gun barrel wear, ammunition jump and powder temperature.

It can also act as the manual input backup station for the automatic sensor target range and crosswind sensor data.

Other switches fitted include the system mode selector and the automatic gun fire on/off control. A separate ammunition selection/indication unit is also provided

5) automatic sensor package with a cant sensor unit that provides pitch/ roll corrections when firing-on-the-move; gun position sensor which interfaces with the stabilised head mirror unit to provide accurate gun position data for the gun tracking and crosswind sensor which can also integrate air pressure and temperature data; and gun elevation assembly which measures the angle above the turret for electrical gun-to-sight line

6) muzzle reference unit which provides internal boresight verification to compensate for gun droop and bend by reflecting into the eyepiece of the laser visual unit via its mirror a light beam generated by the same unit in its muzzle reference system mode



Components of SABCA Universal Tank Fire-Control System

378 AFV FIRE CONTROL SYSTEMS / Belgium

7) gunner's control unit with electrical adjustment switches for the boresight, plumb level, synchronisation and muzzle droop/bend and an automatic gyro drift correction facility

8) interconnecting cable set.

For an engagement the commander locates a target with his existing optical rangefinder sight, slews the turret round to its azimuth by using his hand controller and hands it over to the gunner who locates with own sight.

The commander decides on one of the four possible ammunition types and relays his choice to the gunner, who feeds the information to the computer via his control panel. The gunner starts to track the target by laying the single graticule in his sight onto it and fires the laser. The target range and ammunition type are then displayed in the gunner's eyepiece. The computer processes all the pre-set manual parameter and automatic sensor inputs and calculates the corrected gun aiming angles, which are passed on as command signals, to drive the independent gun/turret drive and stabilisation system.

The gunner, meanwhile, continues to track the target in his sight. He then presses the trigger to enable the gun firing circuit and, as his line-of-sight and the gun settings coincide, the gun is automatically fired by a command generated by the computer which determines when the weapon is within a pre-defined aiming window.

The entire process from initial target detection by the commander to weapon firing is entirely automatic and can take as little as seven seconds to achieve

Status: Development complete. Ready for production.

Manufacturer: Société Anonyme Belge des Constructions Aéronautiques (SABCA), Electronics Department, 1470 Chaussée de Haecht, B-1130 Brussels, Belgium.

Telephone: (02) 246 25 11 Telex: 21237 Fax: (02) 216 15 70

Oldelft LRS 5 Fire-Control System

Development

Designed for use in most types of MBTs and other AFVs, the Oldelft LRS 5 fire-control system comprises in its basic form the LRS 5 D, the periscope part of the LRS 5 with only the day sight fitted and no laser rangefinder or ballistic computer.

With a second generation passive night vision periscope fitted the designation becomes LRS 5 DN. If the laser rangefinder is interfaced into the assembly the designation becomes LRS 5 DNL and with the ballistic microcomputer to control the aiming mark the most sophisticated and fully integrated LRS 5 DNLC monobloc variant is produced.

Description

The main components of the LRS 5 DNLC assembly are:

- a) × 1 magnification episcope
- b) × 8 magnification day sight
- c) \times 6 magnification passive second generation image intensifier night vision sight
 - d) 1.064 µm Nd-YAG laser rangefinder
- e) a digital ballistic microcomputer programmed for up to four types of ammunition. It has a moving target engagement capability and a computer driven ballistic aiming mark. Manual input corrections are required for crosswind, ammunition powder temperature, ambient air temperature and altitude
 - f) manual range input as first emergency backup system
 - g) ballistic graticule as second emergency backup system. The system provides an identical firing sequence for both day and night operation with a visual warning for all system parameters.

Variants

A number of optional equipment fits are available which are given for the various LRS 5 variants in the accompanying table.

Variant	Gunner's cant angle sensor		Comma commander's display box	ander's options commander's slaved sight	thermal display
LRS 5 D	-	-			-
LRS 5 DN		yes			yes
LRS 5 DNL	-	yes	-		yes
LRS 5 DNLC	yes	yes	yes	yes	yes

The individual equipment items are:

1) a cant angle sensor which measures up to 15° of the cant angle and sends the result automatically to the computer which then corrects for it in the ballistic computations

- a thermal sight which allows detection and recognition of targets not only at night but also in conditions of poor visibility
- 3) a CDB 5 commander's display box which informs the commander of the parameters used by the gunner and allows him, if necessary, to override the firing sequence
- 4) an SCS 5 slaved commander's sight with similar performance to the LRS 5 optics and which is connected by an interface cable. When combined with the CDB 5 this offers full override capabilities as well as presenting the same day and night images that the gunner sees in his sight assembly.



Oldelft LRS 5 day/night laser rangefinder with built-in ballistic computer and CBD 5 commander's display box

SPECIFICATIONS

WEIGHT (monobloc)
DIMENSIONS
DEPRESSION/ELEVATION

30 kg

250 × 550 × 400 mm

-10° to +35°

Day periscope

MAGNIFICATION FIELD-OF-VIEW DIOPTER RANGE GRATICULES × 8

-5 to +5

adjustable illumination red ballistic aiming mark

black laser cross with tracking mark adjustable illumination white ballistic graticle Night periscope MAGNIFICATION

MAGNIFICATION FIELD-OF-VIEW DIOPTER RANGE GRATICLES × 6 4.8

fixed bi-ocular

adjustable illumination green ballistic aiming mark

adjustable illumination green laser cross with tracking marks

adjustable illumination green ballistic reticle

Laser rangefinder

LASER TYPE WAVELENGTH RECEIVER FIELD RANGE CAPABILITIES ACCURACY

RESOLUTION

Nd-YAG 1.064 µm 0.7 mil

200 to 9995 m ±10 m

MIN RANGE GATING MULTIPLE RETURNS

200 to 4000 m up to two on the display Computer

AMMUNITION TYPES **ELEVATION BALLISTIC** ANGLES. AZIMUTH LEAD ANGLES ACCURACY SYSTEM POWER SUPPLY up to four separate types

up to 50 mils -28 to +28 mils 0.15 mil (1 sigma value) 18 - 30 V DC

Status: Production. In service with six countries including Malaysia (on the SIBMAS Fire Support Vehicle; two units, one for the commander and one for the gunner) and on some ENGESA EE-9 Cascavel 90 mm armoured

5 m

Manufacturer: Optronic Instruments & Products (OIP), Westerring 21, B-9700, Belgium.

Telephone: (055) 33 38 11 Telex: 86489 Fax: (055) 31 68 95 (Member of the Oldelft Group)

NB: OIP is a member of Delft Instruments, which originated in the merger of the Dutch companies Oldelft Group and Enraf-Nonius.

Oldelft LRS 7 Fire-Control System

Development/Description

The OIP LRS 7 is a monobloc laser rangefinder fire-control system for use on smaller AFV turrets. The system is capable of day and night operation in detecting, recognising, identifying and aiming at targets as well as having an anti-air strike capability.

The main functions incorporated into the system are a × 7 magnification day sight, a × 7 magnification night sight, an output mirror mechanically slaved to the main weapon and an episcope. The graticule configuration used is the same for both day and night operations.

Optional equipment includes the fitting of a fully integrated ballistic computer and/or a 1.064 µm wavelength Nd-YAG laser rangefinder.

SPECIFICATIONS

Day/night sight

MAGNIFICATION

+10 m

LINE OF SIGHT ANGLES

-10° to +60°

Laser rangefinder (optional)

OPERATIONAL RANGE RESOLUTION

200 to 9995 m 5 m

ACCURACY MIN RANGE

RECEIVER GATING

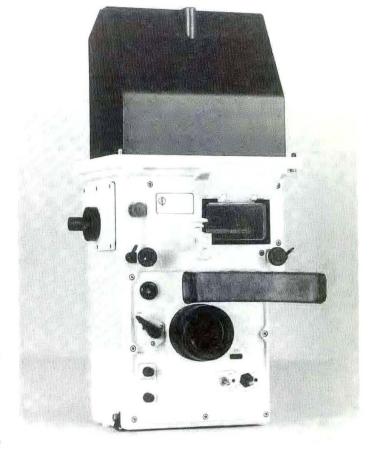
200 to 3400 m

Status: In production. In service with unspecified countries.

Manufacturer: Optronic Instruments & Products (OIP), Westerring 21, B-9700, Belgium.

Telephone: (055) 33 38 11 Telex: 86489 Fax: (055) 31 68 95

(Member of the Oldelft Group)



Oldelft LRS 7 fire-control system

CANADA

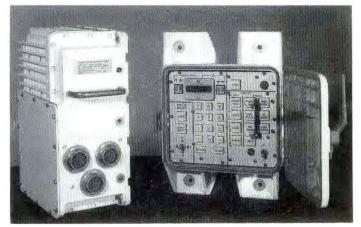
Computing Devices Canada M1/M1A1 Ballistic Computer System

Development/Description

The M1/M1A1 Ballistic Computer System (BCS) is a fully automatic control system. It accepts atmospheric, ballistic and orientation data from the sensors, computer keyboard and fire-control components and uses it to compute the pointing information for the main gun. It then outputs it as control directives to the gun/sight servo mechanisms.

The system comprises two sub-units:

- 1) a Computer Electronics Unit (CEU), which contains a 16-bit microprocessor with analogue and digital input/output circuitry, power regulators and the interfaces with the other elements of the fire control system
- 2) a Computer Control Panel (CCP) for the gunner, which consists of an integrated sealed keyboard containing the numeric and control keys, a legend display panel and a five-character numeric readout for displaying data on entry or recall.
- In operation with an integrated fire-control system the data input comprises three major components
- a) permanent ballistic information which is stored in the memory of the
- b) transient information (such as atmospheric conditions, sight corrections, powder temperature and tube wear) which is manually entered via the CCP



Computing Devices Canada Electronics Unit (left) and Computer Control Panel components of M1/M1A1 MBT Ballistic Computer System

c) dynamic information which is automatically received via the electronic interfaces from the sensors and control servos.

All the gunner has to do is use his sight and control handles to maintain the line-of-sight on the target. At the same time the input data from the sensors and the feedbacks from the control servos of the sight and main armament are sampled via the computer and entered into its memory. This information, together with the ballistic data and the manually entered parameters, is used to compute the required offsets in main gun elevation and azimuth from the line of sight. The servo loops controlling the sight and gun are closed by the computer using rate and position feedbacks. This data is then continually combined with the offset computations to determine the command signals for the output to the control servos. The gun is thus continually aligned so that its trajectory will intersect the line-of-sight at the target range. The gunner then fires the weapon when his line-of-sight indicator is on the target at the point of highest hit probability.

The M1 system also controls the auxiliary weapons but it is equally applicable and adaptable to any turret weapon for various applications including anti-aircraft engagements.

A modified version is being produced for South Korea's Type 88 MBT

and an M48A5 retrofit kit. The system has also been successfully integrated with the Close Combat Vehicle Light programme and the M60A1 MBT.

SPECIFICATIONS

WEIGHTS
electronics unit 12 kg
entry and test panel 5 kg
DIMENSIONS

electronics unit $100 \times 230 \times 330 \text{ mm}$ entry and test panel $80 \times 180 \times 300 \text{ mm}$ POWER SUPPLY $24 \pm 6 \text{ V DC}$ vehicle supply

Status: In production (10 000 plus systems produced to date - 1 January 1993). In service with the US Army on M1/M1A1 and in a modified form on the Type 88 MBT being built in South Korea.

Manufacturer: Computing Devices Canada, PO Box 8508, Ottawa, Ontario, Canada K1G 3M9.

Telephone: (613) 596 7468 Telex: 053 4139 Fax: (613) 596 7392

Computing Devices Canada Improved Computer Control Panel

Development/Description

The Improved Computer Control Panel (ICCP) is a development of the M1/M1A1 Computer Control Panel (CCP). When connected to the ballistic Computer Electronics Unit (CEU) subsystem the ICCP allows the operator to change, enter and monitor gun laying data in the CEU. Any data entry is facilitated by system prompts.

The fire-control parameters can be continuously displayed during normal operations when the system is not in data entry, test or calibration mode.

Manual data entry consists of ambient air and ammunition temperatures, barometric pressure, ammunition type, tube wear and battle range. The ICCP will first show on its electroluminescent screen the currently stored data and the limits of the allowable entries before the operator can enter any new value.

The sensor inputs can include crosswind velocity, cant, lead and range data which are then automatically processed by the ICCP's own microprocessor and displayed with sensor status and polarity. The status can be changed if required by the operator using a designated function key.

The calibration modes available include boresight, zeroing, MRS and MRS boresight and are chosen using the set of function keys located to the right of the display panel. In each mode the operator is prompted to the correct procedure with a four-way toggle switch provided to move the graticule to the required position.

The ICCP can be used to instruct a gunner with no previous experience on the system and test him on completion of his training.

Planned system growth could accommodate such requirements as:

- battlefield management
- 2) target prioritisation and stacking
- vehicle system status monitoring
- 4) navigation
- 5) gunner auto-tracking cues
- 6) thermal imaging system backup display.

In terms of space the ICCP does not take up any more room than the M1/M1A1 CCP and it has a 227×76.2 mm display area. The keyboard is also the same in having the numerics 0-9, a decimal point, test, clear, enter and minus sign keys and the four-way toggle switch, but all the remaining keys have been replaced by four keys to the right of the display which change function according to the system mode.



Computing Devices Canada Improved Computer Control Panel

Status: Production. Used in conjunction with M1/M1A1 Ballistic Computer.

Manufacturer: Computing Devices Canada, PO Box 8508, Ottawa, Ontario, Canada K1G 3M9.

Computing Devices Canada M60A3 Modified Fire Control System

Development/Description

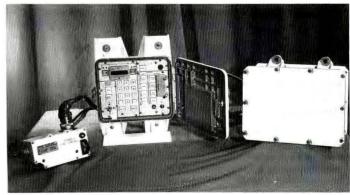
The Computing Devices Canada has developed the Modified Fire-Control System (MFCS) as a retrofit kit for the M60A3 TTS MBT configuration. Based on the M1 Ballistic Computer System (BCS), the MFCS involves the following main changes to the M60A3 system:

- 1) conversion of the existing M21 analogue ballistic computer to a fully digital unit
- replacement of the existing gunner's control unit with the Computer Control Panel (CCP) of the BCS
- 3) complementary modifications of the Field Test Set and the Cable Test Set $\,$
- modification of the ballistic graticule in the gunner's M105D auxiliary telescopic sight
 - 5) provision of ILS and manufacturing technical data packages.
- The retrofit can be performed at the depot level and requires no special tools other than a mounting jig for the CCP.

Status: Development complete. Ready for production.

Manufacturer: Computing Devices Canada, PO Box 8508, Ottawa, Ontario, Canada K1G 3M9.

Telephone: (613) 596 7468 Telex: 053 4139 Fax: (613) 596 7392



Computer Control Panel (left) and modified M21 Analogue Computer (right) components of M60A3 Modified Fire-Control System from Computing Devices Canada

Computing Devices Canada M48 Ballistic Computer System

Development/Description

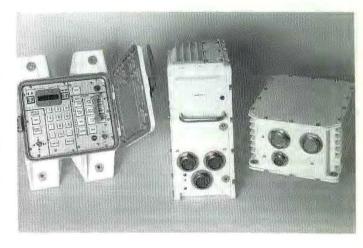
The Computing Devices Canada has developed a Ballistic Computer System (BCS) for the 105 mm gun equipped M48A5 MBT. The kit can also be used to retrofit M60 MBTs. The BCS comprises the following components:

- 1) Computer Electronics Unit (CEU) which accepts the sensor inputs and then calculates the ballistic lead, parallax, zeroing and boresight correction values and outputs them as offsets in
 - a) azimuth to the graticule projection unit of the Tank Thermal Sight
 - b) elevation to the output unit for the gun control system
- 2) Computer Control Panel (CCP) which serves as the man-machine interface for the system and provides the display to monitor inputs and the keyboard to change atmospheric sensor and gun laying data in the CEU. It can also be used to initiate a manually activated fire-control test routine and display the results
- 3) Electronic Interface Unit (EIU) which provides the interface between the CEU and the remainder of the tank fire-control system.

Status: In production (1200 systems produced to date - 1 January 1993). In service as a retrofit kit for M48 MBTs.

Manufacturer: Computing Devices Canada, PO Box 8508, Ottawa, Ontario, Canada K1G 3M9.

Telephone: (613) 596 7468 Telex: 053 4139 Fax: (613) 596 7392



Computer Control Panel (left), Computer Electronics Unit (centre), and Electronic Interface Unit (right) components of the M48 Ballistic Computer System from Computing Devices Canada

Computing Devices Canada Vehicle Command and Tactical Information System (VCTIS)

Development/Description

The VCTIS is designed to aid unit and vehicle commanders in exchanging and assimilating tactical information quickly and accurately. It also provides a facility by which the data can be rapidly presented and transmitted in graphical/textual form.

The system comprises the following components:

- a) Commander's Display Module with a large 203 mm $\times\,203$ mm high resolution (64/100 line) ElectroLuminescent (EL) computer generated digital display with interactive touch panel. The display presents NATO standard topographical and tactical information graphics from the Mobile Mass Storage Unit and includes friendly locations, obstacles, targets and control measures. The interactive touch panel and computer menu allows the commander to add free-draw graphics and text overlays directly to the map display and to transmit manoeuvre orders and formatted messages over the combat net radio
- b) Central Processing Unit with two MC 68020 microprocessors, a 4 Mbyte RAM, interfaces for a 1553 control bus, an RS485 high speed display bus and an RS422 serial data bus. An SCSI hard disc interface and a radio modem are also included
- c) Mobile Mass Storage Unit which comprises a 160 Mbyte hard disc which is upgradable to 600 Mbyte standard
 - d) interfaces to combat radio net and land navigation system.

Status: Ready for production.



Computer Devices Canada Vehicle Command and Tactical Information System (VCTIS) commander's display module

Manufacturer: Computing Devices Canada, PO Box 8508, Ottawa, Ontario, Canada K1G 3M9

Telephone: (613) 596 7468 Telex: 053 4139 Fax: (613) 596 7392

Computing Devices Canada Mission Management Computer System

Development/Description

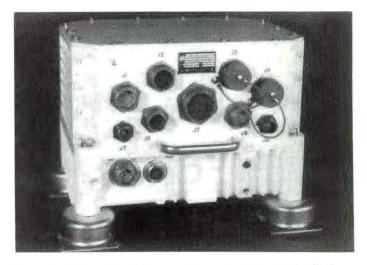
CDC has developed a Mission Management Computer System to meet the requirements of the next generation of MBTs and as a retrofit to all AFVs requiring enhanced computer performance and electronic system integration.

The first application of this system is the Fire-Control System (FCS) for the Vickers Defence Systems Challenger 2 MBT, on order for the British Army. The second application is the FCS for the US Army's Armoured Gun System (AGS). The FCS comprises the following components:

1) Fire-Control Computer (FCC), which is the brain of the weapon system. It accepts data inputs from a wide variety of sources including the Fire-Control Panel (FCP), laser rangefinders, meteorological sensors, vehicle/gun attitude sensors and the sights. It integrates these inputs and outputs the resultant ballistic firing solution as gun pointing data to the Gun Control Equipment. Computation of the ballistic solution takes less than one second.

The FCC houses two Motorola MC68020 microprocessors with MC6881 co-processors operating at 12 MHz. Each processor accommodates 0.5 Mbyte of RAM and 0.5 Mbyte of EEPROM. The FCC acts as the bus controller for the weapon system's 1552B dual-redundant databus. The software for the FCC is written in Ada.

2) Fire-Control Panel (FCP), which is the principle man-machine interface for the FCS. It provides the tank commander with a 76.2 × 127 mm electroluminescent panel, a numeric keypad, fixed function keys and a set



Computing Devices Canada fire-control computer: the heart of the Challenger 2 and AGS weapon control systems

of four programmable keys. The last of these give the operator rapid access to a tree'd series of some 103 screens or 'menus' which enable him to view the system operating parameters, and change them if necessary, to calibrate weapon system functions, to use the extensive Built-In Test Equipment (BITE) and diagnostic facilities in the system and, finally, to retrieve data stored in both the fault log and the engagement log. The FCP is controlled by an Intel 80186 processor and communicates with the FCC over the 1553B databus.

The Mission Management Computer system is designed to provide

state-of-the-art fire-control solutions in real time as well as sensor processing and integration of mission electronic systems. Included in the system is an inherent capacity for further performance growth.

Status: Production. On order for the British Army and the US Army.

Manufacturer: Computing Devices Canada, PO Box 8508, Ottawa, Ontario,

Telephone: (613) 596 7468 Telex: 053 4139 Fax: (613) 596 7392

Computing Devices Canada Automatic Target Acquisition and Tracking System (ATATS)

Development/Description

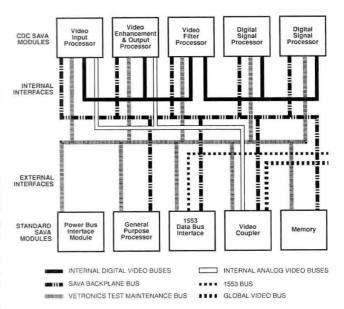
The ATATS has been designed for use with a number of platforms including MBTs. It uses CDC algorithms and advanced digital signal processing techniques to acquire a target and track it automatically through varying conditions of cover and visibility. The ATATS features include:

- (a) continuous monitoring of large fields-of-view
- (b) operations in the infra-red or visible spectrum
- (c) effective on both stationary and moving targets
- (d) suitable for use with scanning or sensors
- (e) configurable in standard and CDC SAVA modules with appropriate internal digital video, internal analogue video, SAVA backplane and Vectronic Test Maintenance buses. A 1553 databus interface is used for information exchange with the crew control and display and other vehicle subsystems whilst a global video bus is used to receive data from the platform's Forward Looking Infra-Red (FLIR) and TV sensors and to output enhanced video tracking notations.

The automatic acquisition and tracking is accomplished through continuous estimation of target parameters such as shape, size, texture and the changes in such parameters. Background features are also used to aid in the isolation of targets

The most significant features of the target or background are analysed as the target moves through the varying conditions. If the target is hidden for extended periods, a search is immediately initiated to re-acquire the target in those regions of the image where it is most likely to reappear.

Status: Trials



Block diagram of Computing Devices Canada Automatic Target Acquisition and Tracking System (ATATS)

Manufacturer: Computing Devices Canada, PO Box 8508, Ottawa, Ontario,

Canada, K1G 3M9.

Telephone: (613) 596 7117 Fax: (613) 596 7392

CHINA, PEOPLE'S REPUBLIC

CEIEC GM-09 Tank Fire-Control System

Development/Description

The GM-09 tank fire-control system is being deployed by the People's Liberation Army as an upgrade package for some of its T-series MBTs and is also being offered on the export market.

The system comprises a series of small-sized units which can be incorporated into most existing turret layouts without difficulty.

The heart of the GM-09 is the central control unit which incorporates an 8080 microprocessor with the control panel and is used to transmit the input signals, compute the firing solution and control the output signals.

Connected to this are a number of sensors and control systems: azimuth rate sensor for the turret; an elevation rate sensor for the main armament with an in-built ammunition selection indicator unit; a gun trunnion tilt sensor; a power supply unit which transforms the vehicle power supply output into the various voltages for the system's individual components; a main armament azimuth and elevation tracking and sighting control handle, modified with a push button engagement system to control the weapon's operation and provide the interface for the automatic gun-laving sequence: a laser rangefinder; and a modified gunner's telescopic sighting system which has an optical system attached to display the computed lead to the gunner by means of an aiming point on a mini-CRT, which is projected into his eyepiece so he can lay it onto the target and fire the gun.

During combat the operational sequence for the system is as follows: the gunner stops the tank temporarily when a target is observed, sights it and then tracks if for three seconds whilst he triggers the laser rangefinder. The computer derives the parameters of the target's movements from the incoming data of target range and angular increments and computes the predicted azimuth and firing angle by utilising any control panel and sensor inputs. This firing solution is simultaneously transmitted to the automatic gun laying device on the weapon control handle and the gunner aims at the target by bringing the inserted aiming point as described onto its centre in the eyepiece and completes the sequence by firing the gun.

The entire process from observing the target to firing the weapon takes not more than 10 seconds with computation taking only about one second.

SPECIFICATIONS

Unit	Weight	Dimensions
CENTRAL CONTROL UNIT	19 kg	$500 \times 400 \times 150 \text{ mm}$
POWER SUPPLY UNIT	11 kg	$280\times210\times240~\text{mm}$
AZIMUTH RATE SENSOR	1.8 kg	$200\times120\times150~mm$
ELEVATION RATE SENSOR	1.3 kg	$130 \times 130 \times 80 \text{ mm}$
TRUNNION TILT SENSOR	2 kg	$140\times135\times90~mm$
MODIFIED CONTROL HANDLE	8 kg	$180\times200\times200~mm$
LASER RANGEFINDER POWER		
SUPPLY	2.25 kg	$176 \times 130 \times 90 \text{ mm}$
LASER RANGEFINDER	7 kg	$344 \times 118 \times 141$ mm
GUNNER'S TELESCOPE SPOT		
INJECTION SYSTEM		$200 \times 60 \times 40 \text{ mm}$
LASER RANGEFINDER		
RANGE		300-6000 m
ACCURACY		±10 m
TRACKING SPEED		
azimuth	not less than	
	40 mils/s	
elevation	not less than	
	10 mils/s	

Status: In production. In service with Chinese People's Liberation Army

Manufacturer: China National Electronics Import and Export Corporation, 49 Fuxing Road, Beijing, People's Republic of China.

Telephone: 810910 Telex: 22475 CEIEC CN



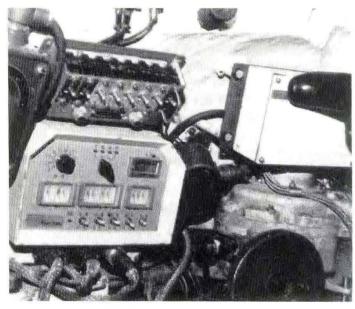
Main components of CEIEC GM-09 tank fire-control system

NORINCO ISFCS-212 Image Stabilised Tank Fire **Control System**

Development/Description

The ISFCS-212 Fire-Control System is believed to be used on a number of the People's Liberation Army T-series MBTs and is also being offered as a retrofit package for other AFVs. The system consists of:

- 1) a ballistic computer with control display/panel and step motor driver
- 2) two-axis gun stabiliser with gyro set and actuating motors package
- 3) sensor package with crosswind velocity, turret angular rate and tilt measuring devices
 - 4) laser rangefinder system with power supply, counter and control unit
- 5) gunner's sight with stabilised field-of-view and interchangeable lowlight level night elbow and unitary vision periscope



Ballistic computer of ISFCS-212 fire-control system

6) commander's sight interface to allow combat direction by overriding gunner's system

The ISFCS-212 has two modes of operation: image-stabilised and graticule automatic setting. In the first the gunner uses his controls to guide his lineof-sight systems. These generate the gun pointing directions which are fed into the gun stabiliser system. The loop is then closed by the gun positions being fed back to the sight so that the weapon continues to follow the target.

The distance is then measured by the laser rangefinder and the ballistic computer calculates the firing solution using the range information from the laser, the target's relative angular rate signals, the trunnion tilt sensor signal, crosswind velocity data, the selected ammunition type and the manual settings. The solution position information is sent to the stabiliser system to set the gun's elevation and lead angle in azimuth. Once the gun reaches this position the control unit generates a fire permitting signal for the gun firing circuit and the gunner can press the trigger.

In its second operating mode the image-stabilised gyro unit is locked, so that the field-of-view is no longer stabilised. The turret angular sensor generates an azimuthal angular rate signal for the target. Then, following ranging with the laser, the computer calculates the firing solution which is sent via the step motor driver to the gunner's sight. Here it automatically sets the ring graticule and all the gunner has to do is align this onto the target and fire the main armament

SPECIFICATIONS SYSTEM OPERATING RANGE 200-3990 m PROCESSING RANGE ACCURACY ±10 m TARGET TRACKING RATE -20 to +20 mils/s -10 to +10 mils/s elevation TARGET TRACKING RATE PROCESSING ACCURACY azimuth +0.4 mils/s elevation ±0.4 mils/s

Status: In production. In service with Chinese Army.

Manufacturer: China North Industries Corporation, 7A Yuetan Nanjie, PO Box 2137, Beijing, People's Republic of China.

Telephone: (86) 6898/3461/3471/7570 Telex: 22339 CNIC CN

COMMONWEALTH OF INDEPENDENT STATES

T-64, T-72, and T-80 MBT Fire-Control Systems

Development/Description

On the basic T-72A and T-72B models the initial part of the engagement sequence is similar to that described for the T-62 MBT with the commander using his stadia rangefinder sight to determine the target range.

For the T-64 and T-64A, with coincidence rangefinders for more accurate long range firing, and the laser rangefinder sight assembly equipped T-64, T-64B and T-80 series, the gunner himself uses the rangefinding system to determine the range. The information is fed to the ballistic computer as well as being displayed to the gunner and commander.

On all the T-64, T-72, and T-80 series tanks both the gunner and commander can elevate and fire all the weapons from their respective positions.

On the laser equipped tank models the gunner's sight uses an inverted V-shaped aiming mark. On either side of this are 1-mil graduations out to 33 mil providing a 3.8° field-of-view. Four small spaced aiming marks to each side show the lead angles required for crossing targets at various speeds. The gunner tracks the target using the aiming mark

The measured range from the laser unit is collated with any other sensor information and all the manually input data by the analogue fire-control computer, which uses it to calculate the appropriate weapon lead angle and then displaces the gunner's aiming mark to the left or right as required. The gun super-elevation is automatically calculated for the given range and laid into the elevation mechanism by the computer after taking into account the pre-set ammunition type's ballistic characteristics.

All the gunner then has to do is relay the aiming mark back onto the target by using his two-handed electrically operated controller and press the firing trigger.

For all the tank types, when the gunner is ordered by the commander to load the main gun he selects the designated round type on his control panel and the autoloader system goes through its automatic separate ammunition loading sequence with the gun moved to the elevated position. When completed the weapon will revert to its previous elevation setting.

Improvements to some T-64Bs, have been made.

Status: All the various system components are in production. They are all in service with the former Soviet Army with exports of the laser rangefinder model having been made to selected client nations only on T-72G and T-72M1s

The stadia rangefinder system has been widely exported on the basic T-72 models to the various countries using these tanks.

Manufacturer: Former Soviet state arsenals with licensed production of the stadia/laser rangefinder systems in the Czech Republic and Slovakia, India and Poland. Yugoslavia has been self-sufficient in lasers and optics for some time so has installed a locally designed fire control equipment, the SUV-84 (qv), in its licence-built tanks.

T-54, T-55 and T-62 MBT Fire-Control Systems

Development/Description

None of the three basic T-54, T-55 and T-62 tank models has a mechanical rangefinder or ballistic computer for their main armament, so the fire-control operation is conducted in the following manner:

The vehicle commander uses his binocular target designator sight for searching on his side of the tank whilst the gunner uses his rotating periscope to search the other side. The driver and loader watch the front through their fixed vision systems. Anyone spotting a target gives its bearing over the crew intercom system and the commander or gunner traverses the turret in that direction using their hand traverse controllers. For the power traverse system to be used there must be a round in the gun breech and the weapon safety lever depressed to the fire position, otherwise the process has to be controlled manually. In the case of the T-62 the manual traversing can only be handled by the gunner.

If the commander traverses the turret he announces "override right (or left)" over the intercom and depresses the override button on his sight's handgrip until the gunner says "identified" as the target appears in his sight optics. The commander cannot fire or elevate the gun. He then normally determines the target range. If it is around 2.7 m high he uses the rangefinding stadia on his sight, seeing which of the graticules and baseline bracket the target. If it is much less than 2.7 m he has to use the azimuth scale and a simple mathematical formula to determine the range.



If the commander cannot determine the range for any reason the gunner takes over the task and uses his telescopic sight's stadia rangefinder or its lateral lead and azimuth lines with the rangefinder formula.

For the T-62 only the gunner's stadiametric sight is suitable for rangefinding at night.

When the range has been determined the commander gives the firing command over the intercom, including the ammunition type to be fired, target type, range and direction. The gunner then elevates the gun so that the black range line in his sight's field-of-view coincides with the designated target range on the selected ammunition type range scale. If the gun is not yet loaded the loader is ordered to load the selected ammunition type and depress the weapon safety lever to the required fire position. The gunner then tracks the target using his power controller grips either by centring the sight aiming point on a stationary target or by using the lead lines to lead a moving target. Once satisfied he selects the main gun switch, which also activates the automatic shell extraction unit on the T-62, and announces "ready" over the intercom net.

The vehicle commander orders "fire" and the gunner either depresses the electrical firing trigger on the right hand grip or a manual weapon trigger on the elevation handcrank on the gun itself.

After discharging the projectile the T-62 gun's automatic shell extraction and reloading position sequencer operates so that the gunner cannot continue traversing to follow a moving target. As soon as the gun safety lever, however, is depressed again after reloading to the fire position the gun will, if the stabilisers are set, automatically return to the previous firing position.

Although the type of fire-control system described above is ideally suited to the former Soviet concept of most tank versus tank engagements taking place below 1500 m in range using relatively unsophisiticated armour penetrating ammunition types, a large number of their T-54, T-55 and T-62 MBTs have, since the late 1970s, been equipped with a laser rangefinder/target designator unit mounted in an armoured box over the main gun. This system can be used by either the commander or the gunner with its output going to an associated ballistic fire-control computer to improve the vehicle's long range gunnery capabilities, especially with more advanced ammunition types.

Status: Component production as required. In service with many countries worldwide.

Manufacturers: Former Soviet State factories and several licensed countries including the Czech Republic and Slovakia, Poland and North Korea.

The standard T-62 MBT does not have a laser rangefinder

SPECIFICATIONS Sight T-54 TPK-1 COMMANDER'S	Magnification	FOV	Sight T-62 TKN-3 COMMANDER'S DAY/ NIGHT BINOCULAR SIGHT	Magnification	FOV
BINOCULAR SIGHT	n/av	n/av	day mode	× 5	10°
TSh2-22 GUNNER'S PERISCOPIC SIGHT T-55	\times 3.5 and \times 7	n/av	IR night mode TSh2B-41u GUNNER'S PERISCOPIC SIGHT	× 4.2	8°
TPKU-2B COMMANDER'S			day mode	× 7	9°
BINOCULAR SIGHT TSh2B-22P GUNNER'S	n/av	n/av	IR night mode TPN-I-41-II GUNNER'S IR	× 3.5	18°
PERISCOPIC SIGHT	n/av	n/av	MONOCULAR PERISCOPIC NIGHT SIGHT (FOR USE WITH THE MAIN L-2G OR IPN-22MI		
			SEARCHLIGHT)	× 5.5	6°

THE CZECH REPUBLIC AND SLOVAKIA

Kladivo Tank Fire-Control System

Development/Description

The first conversion of T-54/T-55 tanks with the Kladivo Fire Control System (FCS) were observed in service with Czechoslovakia in 1984 and since then Bulgaria, Hungary, Poland and the former Soviet Union have updated some of their T-55s to the same standard (Note: the former East German Army also fielded similar upgraded T-55 tanks, for example, the T-55AM2B).

However, there are slight differences in detail between the vehicles of each country, for example, Polish T-55s have the laser rangefinder integrated with the gunner's sight and a hammer-shaped crosswind sensor on the front of the turret roof. A partial list of the Kladivo equipped models is:

Country	Vehicle designator	Remarks
Bulgaria	T-55AM2	Soviet built T-55A(M) with Kladivo and additional armour
CIS	T-55AM2B	T-55 with Kladivo and AT-11 'Bastion' ATGW capability
The Czech Republic and Slovakia	T-54AM2	T-54 with Kladivo
The Czech Republic and Slovakia	T-54AMK	command version T-54 with Kladivo
The Czech Republic and Slovakia	T-55AM1	T-55 with Kladivo
The Czech Republic and Slovakia	T-55AM2	T-55 with Kladivo and new engine
The Czech Republic and Slovakia	T-55AM2K	command version T-55 with Kladivo and new engine
Hungary	T-55AM	Czech built T-55AM with Kladivo

The Kladivo FCS comprises a laser rangefinder mounted externally above the mantlet of the 100 mm gun, ballistic fire-control computer, wind velocity sensor, mast-mounted meteorological sensor (that also incorporated a laser warning device), operating control switch, data input devices, commander's periscopic sight, ammunition selection switch and power supply.

The laser may be triggered up to 10 times a minute but its performance is degraded in rain, snow and fog. The rear turret roof-mounted armoured meteorological mast contains ambient air and pressure sensors as well as the laser warning device. The latter is used to warn the crew if they are being lased by enemy tanks or target designators.



The operating control switch allows the gunner, in case of a system malfunction, to switch off the complete FCS and carry out a conventional target engagement. The input device is operated by the tank commander and, in addition to the digital input keyboard panel for the manual input of data in the fire-control computer, there is a digital display field. The computer is capable of estimating target speed and direction for the establishment of the fire-control solution lead angle.

The commander's periscope is installed in the commander's cupola and allows independent observation of the target by the commander and the automatic hand-off of the target to the gunner.

The loader operates the ammunition selection switch and has a choice of five different conventional ammunition types, with the actual selection being made by the tank commander on the basis of the target type. The ammunition types are HE, HEAT, incendiary, APFSDS and machine gun. The power supply unit maintains a constant voltage for the system.

The installation of the Klavido FCS has enabled the upgraded T-54/T-55 vehicles to engage moving targets out to an effective range of 1600 m with a high first round hit probability. With the other elements of the upgrade package, that is new engine, additional armour and so on, the updated vehicle is said to be nearly as combat effective as an American M60A1 or French AMX-30 B2 MBT.

Status: Production as required. In service with the armies of Bulgaria, the Czech Republic and Slovakia, Hungary and the CIS.

Manufacturer: Czech and Slovakian state factories plus probable licence component/system manufacture in one or more of the other user countries.

Czechoslovakian T-55AM2 MBT showing laser rangefinder over 100 mm gun

FRANCE

SOPTAC 11 IR Control System

Development/Description

This Fire-Control System is the third generation day/night version of the SOPTAC 11 system (qv), with the image intensifier channel replaced by a thermal imaging unit and the digital computer by a third generation version.

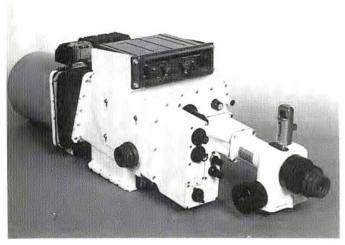
All the other modules including the laser rangefinder are interchangeable between the systems.

The SOPTAC 11 IR system comprises the following subsystems:

a) a Capitole telescopic sight assembly with a \times 8 magnification day channel which allows target identification and engagement at the guns maximum range; and a \times 8 magnification thermal channel which operates in the 8-13 μm waveband region and uses the same eyepiece and cross hair graticule as the day channel

- b) digital computer
- c) a laser rangefinder
- d) a commander's control box
- e) a gunner's control box.

The fire-control computer takes inputs for the target range, target speed (along three axes – lateral, vertical and horizontal distance), the slant of the firing platform, the ambient air temperature and pressure, gun sight parallax,



SOPTAC 11 IR FCS

ammunition type selected, cross wind direction and force and initial platform adjustments as to slope and tilt. From these it automatically calculates the sighting direction to the target, which appears as a computer generated moving graticule in the telescopic sight's field-of-view.

The thermal imaging unit is the same Thomson-TRT type as fitted to the Mithridat fire-control system (qv) and uses a cooled low temperature HgCdTe detector system.

Projected fits for the SOPTAC 11 IR include the Giat Industries TS 90, 90 mm, two-man turret and other similar turrets.

SPECIFICATIONS

DIMENSIONS ELEVATION LIMITS	1020 × 330 × 264 mm -8° to +20°
Daylight channel	× 8
MAGNIFICATION FIELD-OF-VIEW	70
Thermal channel	
MAGNIFICATION	× 8
FIELD-OF-VIEW	6 × 3°
POWER SUPPLY	20-30 V DC
RANGE	
detection	5000-6000 m
recognition	3000 m
identification	2000 m
Laser rangefinder	
RANGE	300-9990 m
ACCURACY	±5 m
Fire-control range	

Status: Development complete. Ready for production.

Manufacturers: SOPELEM-SOFRETEC, 53 rue Casimir Périer, PO Box 62, 95872 Bezons Cedex, France.

3500 m 2500 m

Up to 4

Telephone: (1) 34 23 30 00 Telex: 605793F Fax: (1) 34 23 33 50

Thomson-TRT Defense, Optronics Division, rue Guynemer, BP55, F-78283 Guyancourt Cedex. France.

Telephone: (1) 30 96 70 00 Telex: THOM 616780F

Fax: (1) 30 96 75 50

AMMUNITION TYPES

RANGE APDS

HEAT

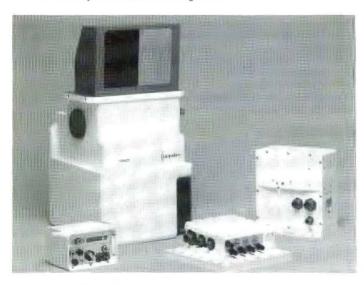
Mithridat Fire-Control System

Development/Description

The Mithridat third generation day/night (thermal imaging) fire-control system is under development as a joint venture by SOPELEM and TTD.

It is designed for use on tanks and armoured vehicles and its subsystems will equip the commander and gunner stations with small integrated day/night periscope sights and associated electronics. The main components of the system are:

1) a modular periscope sight, which is fitted with a unity-magnification large field acquisition system, a $\times\,8$ magnification observation and target engagement day channel, an 8-13 μm spectrum band thermal imaging day/night channel which is a variant of TTD's Mira night sight used on the MILAN ATGW system and a laser rangefinder



Mithridat Fire-Control System components

- 2) digital computer
- 3) vehicle commander's control panel
- 4) gunner's control panel.

The computer system takes the data from the subsystem components and manual inputs in the form of distance to target, firing platform speed in all three axes, slant angle, ambient temperature and pressure, gun/telescope distance, ammunition type selected, crosswind velocity and, if required, gun arc and uses it to calculate the tracking line which then appears as a cross in the field of the sight. When this coincides with the target the gunner fires.

SPECIFICATIONS (provisional)

DIMENSIONS MODULAR

SIGHT SYSTEM 550 \times 282 \times 350 mm POWER SUPPLY 24 \pm 6 V vehicle supply

Day sights

 MAGNIFICATIONS
 × 1
 × 8

 FIELD-OF-VIEW
 25 × 12°
 7°

Thermal sight

 $\begin{array}{lll} \text{MAGNIFICATION} & \times \, 8 \\ \text{FIELD-OF-VIEW} & 6 \times 3.3^{\circ} \\ \text{ELEVATION OF THE} & -12^{\circ} \, \text{up to } +35^{\circ} \\ \text{HEAD UNIT} & \text{or } -12^{\circ} \, \text{up to } +55^{\circ} \\ \text{LASER RANGEFINDER} & \end{array}$

OPERATING RANGE 150-9990 m ACCURACY ±5 m

Status: Prototype.

Manufacturers: SOPELEM-SOFRETEC, 53 rue Casimir Périer, PO Box

62, 95872 Bezons Cedex, France.

Telephone: (1) 34 23 30 00 Telex: 605793F Fax: (1) 34 23 33 50

Thomson-TRT Defense, Optronics Division, rue Guynemer, BP55, F-78283 Guyancourt Cedex, France.

Telephone: (1) 30 96 70 00 Telex: THOM 616780F

Fax: (1) 30 96 75 50

SOPELEM SOPTAC 11 Fire-Control System

Development/Description

The SOPTAC 11 is a second generation day/night (light intensification) fire-control system for use with such turrets as the Giat Industries TS 90 and Hispano-Suiza Lynx 90.

The system consists of five main subsystems with an optional sixth:

1) a $1.06\,\mu m$ wavelength laser rangefinder. The laser controller transmits the range data to the computer and also calculates the approach velocity of the target by making a second measurement at the end of the tracking sequence and comparing the two

2) a TJN2 90 telescopic sight, which allows observation and firing by day and night. Both the day and night channels have \times 6 magnification, with the night vision being provided by a second-generation image intensifier tube

3) a computer which calculates gun elevation and traverse

 4) the commander's control and display panel on which he can enter certain fire-control parameters and supervise operations

5) a gunner's control panel which can have an optional link from it and the TJN2 90 sight to the commander's display panel so that the commander can have the same night vision and aiming picture as the gunner

6) an optional \times 8 magnification day periscope sight with a 6° field-of-view in place of the current \times 6 day channel system.

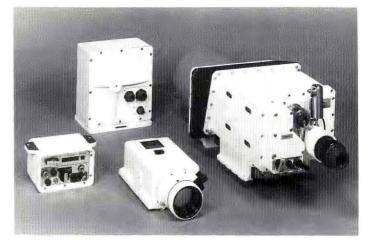
The operating procedures for the system are very simple. All the gunner has to do is track the target, press and release the tracking button and finally fire. The vehicle commander has to select the type of ammunition to be used and check that the fire-control procedure has been carried out correctly.

If the target range is greater than 2550 m and APFSDS ammunition is not being used the computer will automatically switch over to its artillery support mode. This permits the gun to be aimed and fired at high angles of elevation and visually indicates to the tank commander that only HE rounds can be fired.

Status: In production. In service with the French Gendarmerie and Oman (VBC 90 with Giat Industries TS 90 turret).

Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimir Périer, PO Box 62, F-95872 Bezons Cedex, France.

Telephone: (1) 34 23 30 00 Telex: 605793F Fax: (1) 34 23 33 50



SOPELEM 11 fire-control system components TJN2 90 day/night sight (right), laser rangefinder (centre front), fire-control computer (centre rear), vehicle commander's display and control panel (left)

SPECIFICATIONS Laser rangefinder

 RANGE
 300-9990 m

 fine weather
 300-9990 m

 limited visibility
 150-3000 m

 ACCURACY
 ±10 m

 Day sight

 MAGNIFICATION
 × 8

 FIELD-OF-VIEW
 6°

 DIOPTER RANGE
 -5 to +2

 Night sight

 MAGNIFICATION
 × 6

 FIELD-OF-VIEW
 6°

 DIOPTER RANGE
 -5 to +2

SOPELEM SOPTAC 18 Fire-Control System

Development/Description

The SOPTAC 18 first generation day-only fire control system is designed for use as an upgrading package for the current FL-12 turret (on AMX-13 light tank) sighting systems without any need for modification of the turret.

It comprises a rigid frame fixed within the turret that holds the following items

- 1) digital computer
- 2) a laser rangefinder with control unit

3) a gunner's projected graticule module which adjusts the position of the graticule in the aiming sight according to the computer calculated parameters. During the night, the day sight is replaced with a night sight.

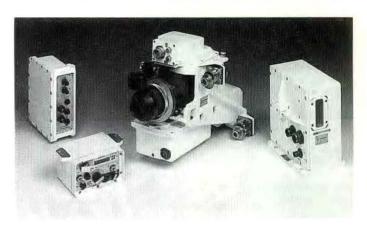
Without this the SOPTAC 18 allows observation and daytime firing on stationary or moving targets with laser rangefinding. The computer takes both subsystem and manual input data in the form of target distance, target speed, cant angle, ambient temperature and pressure, ammunition type selected and crosswind velocity and uses it to calculate the axis of firing.

In June 1988 SOPELEM was awarded a FFr42 million contract for the supply of SOPTAC 18 fire-control systems for installation in the AMX-13 light tanks of Ecuador.

SPECIFICATIONS

SYSTEM OPERATING RANGE LASER ACCURACY SYSTEM ACCURACY

300-9990 m +10 m $+0.3 \, \text{m}$



SOPELEM SOPTAC 18 Fire-Control System

Status: Production. In service with Ecuador (on 108 AMX-13, daylight only version)

Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimir Périer, PO Box 62. F-95872 Bezons Cedex, France.

Telephone: (1) 34 23 30 00 Telex: 605793F Fax: (1) 34 23 33 50

SOPELEM SOPTAA 19 Fire-Control System

Development/Description

The SOPTAA 19 Fire-Control System is designed for the direction of weapons in the defence of ground positions and vehicles against attack from aircraft or helicopters. It is used with lightweight vehicle-mounted turrets armed with 20 mm cannon. The main subsystems are:

- 1) a periscopic gunner's sight derived from the M371 and with its elevation aiming prism mechanically linked to the gun
 - 2) an electronic control panel with integral computer
 - angular transducers or tachogenerators mounted on the cannon 3)
- 4) a hand-held target designator system which automatically calculates the necessary parallax between the operator and weapon and then provides for the automatic alignment of the turret onto the target.

System operation requires two men: the observer/fire director who detects and designates the target and the gunner who operates the sighting system and fires the gun.

The sight has a projected aiming graticule and separate optical channels for engaging ground and aerial targets. In the latter mode it is possible to have an engagement sequence time of between 5-6 seconds which allows a target designated at 2000 m distance to be fired on at a range of 1000 m with an accuracy of ±5 mil.

SPECIFICATIONS POWER SUPPLY 24 ±6 V DC vehicle supply Ground target channel MAGNIFICATION FIELD-OF-VIEW 10 Aerial target channel MAGNIFICATION $\times 1$ FIELD-OF-VIEW vertical 26 horizontal 710 **ELEVATION AIMING** RANGE -15° to +55°

Status: Development complete. Ready for production.

Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimir Périer, PO Box 62, F-95872 Bezons Cedex, France

Telephone: (1) 34 23 30 00 Telex: 605793F Fax: (1) 34 23 33 50

SOPELEM SOPTAM Fire-Control System

Development/Description

The SOPTAM Fire-Control System has been developed for use with the Hispano-Suiza Serval 60 mm mortar turret and in the Giat Industries TMR 81 turret, and consists of the following subsystems:

- 1) a Type M 477-03 sight
- 2) an electronics unit
- 3) an inclinometer
- 4) interconnecting cable set.

In operation the gunner uses the equipment to make the appropriate corrections to the mortar settings in order to take into account the attitude of the vehicle on the ground, including the degree of slope it is operating on.

Status: Production as required. In service with several unspecified countries.

SPECIFICATIONS

WEIGHT OF ELECTRONICS 2.5 kg WEIGHT OF INCLINOMETER 1 kg DIMENSIONS OF **ELECTRONICS UNIT**

212 × 58 × 250 mm **ELEVATION ANGLE** MEASUREMENTS up to 70° ACCURACY 0.8 mil

DEFLECTION AND SLOPE CORRECTION up to 10°

MAX ERROR IN BEARING CORRECTION 5 mil for a level angle of 1100 mils

Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimir Périer, PO Box 62, F-95872 Bezons Cedex, France.

Telephone: (1) 34 23 30 00 Telex: 605793F Fax: (1) 34 23 33 50

SOPELEM SOPTAC 36 Fire-Control System

Development/Description

The SOPTAC 36 modular second generation day/night (light intensification) fire-control system has been developed to equip the gunner's position in light armoured vehicles and tanks.

The system consists of the following subsystems:

- 1) a combined day/night periscopic sight system with a day-time firing path, a night-time firing path, a day telescope path and an integral 1.06 μm wavelength laser rangefinder module. The night vision capability is provided by a second or third generation image intensifier tube
 - 2) a digital computer
 - 3) a line-of-sight projection module with mobile cross-hairs that brings

the firing axis to the gunner and, with the use of an optional repeater unit, to the commander's station

- 4) gunner's control panel
- 5) commander's control panel
- 6) aiming device, tachometer generator or encoder, automatic muzzle reference and elevation sensor units.

The system allows daylight and night-time observation and aiming on moving targets with laser rangefinding. The computer takes both subsystem and manual input data in the form of target distance, firing platform speed in all three axes, cant angle, ambient air pressure and temperature, muzzle reference value, gun boresight, mechanical transmission correction value, ammunition type to be used and crosswind velocity, and uses it to calculate the tracking line which then appears as a cross in the field of the sight. When this coincides with the target the gun is fired.

388 AFV FIRE CONTROL SYSTEMS / France — Germany

If the target range is greater than the 2560 m range of the APFSDS flat trajectory ammunition carried, the computer will automatically switch over to its artillery support mode. This permits the gun to be aimed and fired at high angles of elevation and visually indicates to the vehicle commander that only HE rounds can be used.

SPECIFICATIONS

DIMENSIONS $284 \times 350 \times 375 \text{ mm}$

ELEVATION LIMITS -12° to +35° (anti-aircraft option

-12° to +55°)

System range

 direct fire
 3000 m

 indirect fire
 5000 m

 SYSTEM ACCURACY
 ±0.2 mrad

POWER SUPPLY 24 ±6 V DC vehicle supply

Day Periscope sight

MAGNIFICATION \times 1 FIELD-OF-VIEW 25 \times 12

Day/night Telescope sight

MAGNIFICATION day path

 night path
 × 8

 FIELD-OF-VIEW
 4

 day path
 7°

 night path
 7°

 DIOPTER RANGES
 -5 to +2

Laser rangefinder

OPERATING RANGE 300-9990 m

ACCURACY ±5 m

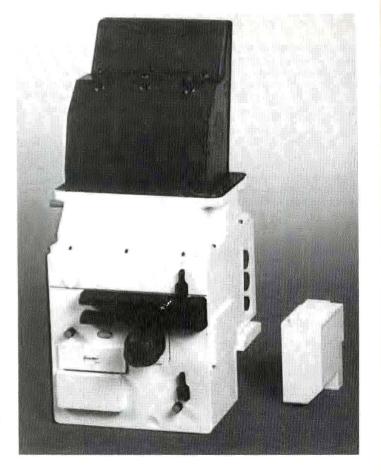
Status: In production. In service with an unspecified South American country as a retrofit package.

× 8

Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimir Périer, PO Box 62,

F-95872 Bezons Cedex, France

Telephone: (1) 34 23 30 00 Telex: 605793F Fax: (1) 34 23 33 50



SOPELEM SOPTAC 36 Fire-Control System

GERMANY

Atlas Elektronik FLT-2/EMES 15 Tank Fire-Control System (TFCS)

Development/Description

The FLT-2/EMES 15 modular 'director-type' TFCS was developed specifically for use on the Leopard 2 MBT, although its modular design does allow for easy installation on other MBT models. It comprises a number of optical, optronic and mechanical subsystems which are integrated to form the complete FCS.

The FLT-2/EMES 15 is used for engaging stationary and moving targets from a stationary or moving platform position. It is also capable of day/night operations.

The main components are:

1) gunner's primary sight with stabilised mirror (in elevation and azimuth), laser transmitter, laser receiver, thermal imaging system and eyepiece assembly. The daylight channel, laser transmission, laser reception and thermal imaging channels are all routed via the same mirror to ensure precise alignment.

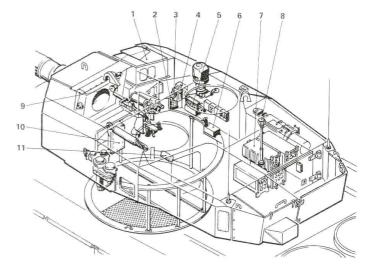
For night, camouflaged targets or poor visibility viewing, the thermal imaging facility is used for target identification and tracking. Target markers are superimposed on the image which is injected into the raypath of the daylight channel.

The tank commander can also use the thermal sight image as the picture is transmitted to his stabilised PERI-R17 primary panoramic sight assembly.

For daylight observation, identification and tracking of the target, the gunner uses a $\times\,12$ magnification and 5° field-of-view periscope. Graticule target range values (to three figures) and system status information (such as ammunition type selected and so on) are superimposed on the lower part of the image in the sight optics by the FCS.

The integrated Nd-YAG laser rangefinder has a measuring range of 9990 m and is accurate to $\pm 10\ \text{m}$

- 2) commander's control unit
- 3) gunner's control unit
- 4) commander's display unit
- 5) computer control unit
- 6) commander's hand control
- 7) digital ballistic computer which calculates successively the angle of sight and lateral angular lead for the 120 mm smooth-bore main gun armament. The following parameters are taken into account: target range, angle of vehicle cant (tilt), direction of motion with regard to the target, cross-wind and the ballistic data of the selected ammunition.



Leopard 2 MBT turret showing position of main components (1) gunner's primary sight, (2) commander's control unit, (3) gunner's control unit, (4) commander's display unit, (5) computer control unit, (6) commander's hand control, (7) computer, (8) crosswind sensor, (9) gun elevation sensor, (10) laser electronics, (11) vertical sensor

The calculated firing solution is then fed to the weapon control and stabilisation system which lays the main gun to the Line-Of-Sight (LOS) of the gunner's or commander's sight as required.

Data on up to seven ammunition types is carried by the computer which also handles the ballistic computations if the commander is firing the main gun with his PERI R17 panoramic sight

- 8) cross-wind sensor
- 9) gun elevation sensor
- 10) laser electronics box
- 11) cant angle sensor
- 12) interconnecting cable set.

The mode of operation is as follows: once a target is identified its range is measured by the laser rangefinder. The gunner (or commander if aiming with the thermal imaging system) then keeps the LOS on the target by means of hand controllers.

The following system facilities are provided as aids in aiming and range correction:

- a) gunner's dynamic lead (with on/off switch)
- b) commander's automatic target tracking integrator (with on/off switch)
- c) tracking action of the LOS to compensate for own vehicle motion
- d) automatic range correction as the tank approaches the target.

The target information obtained is automatically presented to the FCS

computer together with the other firing parameters mentioned above. This then continuously computes the main armament superelevation and lead angle settings. Once locked-on to the target the gunner can open fire with the 120 mm main gun.

Status: Production for Leopard 2 MBT. In service with the armies of Germany, the Netherlands and Switzerland.

Manufacturer: Atlas Elektronik GmbH, Sebaldsbrücker Heerstrasse 235, D-2800 Bremen 44, PO Box 44 85 45, Federal Republic of Germany. Telephone: (421) 457-0 Telex: 2457460 Fax: (421) 457 2900

Atlas Elektronik FLP-10/EMES 18 Tank Fire-Control System

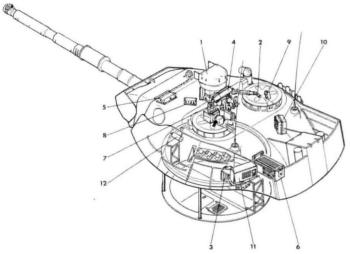
Development/Description

The FLP-10/EMES 18 fire-control system is designed for use with the Leopard 1A1A1, 1A2 and 1A3 main and coaxial armaments for the engagement of stationary and moving targets under day or night conditions with the firing platform itself either moving or stationary.

Following competitive trials with three different fire-control systems, the AEG-Telefunken LEMSTAR-M/EMES 17, the FLP-10/EMES 18 and the Zeiss FLS-L/EMES 12A4, the German Army adopted the FLP-10/EMES 18 in 1984 for retrofitting to 1300 Leopard 1 MBTs. In this application it is combined with a Carl Zeiss thermal imaging system.

The main subsystems are as follows:

- 1) stabilised Gunner's Primary Sight (GPS) with the following subunits:
- a) Nd-YAG 1.06 μm wavelength laser rangefinder transmitter with an operating range of 200-9900 m
- b) laser transceiver with a target resolution of less than 20 m and a measuring accuracy of $\pm 10\ m$
- c) integrated thermal imaging sight which is used at night or in poor visibility for the identification and tracking of targets. Target markers are superimposed on the thermal image created which is interjected into the daylight channel optical path



Atlas Elektronik FLP-10/EMES 18 tank fire-control system in Leopard 1 MBT showing main components

- d) gunner's eyepiece assembly
- e) single stabilised, in azimuth and elevation, head mirror which is used for the daylight visual channel (with a \times 12 magnification and 5° field-of-view), laser transmission/reception and thermal imaging systems.

This ensures the synchronisation of the optical axes and allows both the gunner and commander to aim at the target using either the daylight or the thermal imaging system and perform the required laser ranging.

The identification and tracking of the target in daylight is done by means of a high quality day telescope

- 2) commander's monocular GPS eyepiece assembly which, together with the gunner's eyepiece system, allows either operator to control the Line-Of-Sight (LOS) via the use of hand controls. A graticule, range value and system status information are superimposed on the telescope image
- 3) digital fire-control computer which contains ballistic information for up to seven ammunition types and a computation range up to 4000 $\rm m$
 - 4) computer control panel
- 5) laser electronics unit
- 6) thermal imaging electronics unit
- 7) gunner's control unit
- 8) loader's control unit
- 9) commander's thermal imaging control unit
- 10) gun stabilisation electronics package
- system test/operating mode interface assembly
- 12) vertical sensor unit to automatically eliminate cant angle error from the ballistic computations.

The principle of operation is as follows: the commander identifies a target, slews the turret round to its azimuth and hands it over to the gunner to engage. The gunner aims through his sight, performs the laser range finding task and starts the tracking procedure. The fire-control computer then takes all the manual and automatic input fire-control parameters such as the cant angle correction value, selected ammunition type, powder temperature, ambient atmospheric conditions, target speed and vehicle altitude and continuously calculates the superelevation and lead angles for the armament. The relevant command signals are transmitted to the gun control system, which relays the weapon while not disturbing the LOS, and the offset aiming mark is generated for the sight system.

As soon as the aiming mark is coincident with the actual gun position the firing circuit is complete and the gunner can commence firing.

Status: Production as required. In service with Denmark, Germany, Greece and Norway in upgraded Leopard 1 series MBTs.

Manufacturer: Atlas Elektronik GmbH, Sebaldsbrücker Heerstrasse 235, D-2800 Bremen 44, PO Box 44 85 45, Federal Republic of Germany. Telephone: (421) 457-0 Telex: 2457460 Fax: (421) 457 2900

Atlas Elektronik MOLF Modular Tank Laser Fire-Control System

Development/Description

The MOLF main and coaxial armament day/night fire-control system is based on the technology used in the FLP-10/EMES 18 system for the Leopard 1 MBT family but is designed as a modular retrofit kit for modernising a much wider variety of tanks such as Indian Arjun and Vijayanta MBTs, the T-series including the T-62, the M41, M48 and M60A1 and the AMX-30.

The various sets of modules available are:

- 1) Single-axis stabilised system set for rectangular turret openings (as used on the M41 light tank)
- 2) Two-axis stabilised system set (as used on the M41, M48, M60A1 and AMX-30)
- Single or two-axis stabilised system set for round turret openings (as used on the T-series).

Depending on system configuration each set will normally comprise the following components:

- a) monocular gunner's primary sight with:
 - i) stabilised mirror head
 - ii) mechanical interface
- iii) periscope/sight package with commander's eyepiece assembly, integrated Nd-YAG 1.06 μm wavelength laser rangefinder and \times 12

magnification day sight, 8-12 μ m waveband thermal imaging sight with \times 12 and \times 4 magnification channels, thermal imaging power supply unit and optional image intensifier sight.

The laser rangefinder has a working range of 200-9900 m with an accuracy of ± 10 m and a target resolution of less than or equal to 20 m.

- b) fire-control electronics and sensor package with computer control panel, digital ballistic computer that can handle up to eight separate ammunition types, cant sensor, air data sensor (for crosswind, temperature and pressure), gun elevation sensor and turret rate sensor
 - c) functional system interface electronics unit

The modular design of the system allows all kinds of aiming and LOS stabilisation to be achieved, namely:

- 1) mechanical linkage mirror-gun
- 2) electrically slaved mirror drive in elevation
- electrically slaved mirror drive to stabilised main gun in elevation and independently stabilised mirror in azimuth
- primary stabilised LOS in both axes in combination with a slaved gun stabilisation system.

This makes it possible for the retrofitted tank, while it is either stationary or moving, to fire on a stationary or moving target with a high first round hit probability.

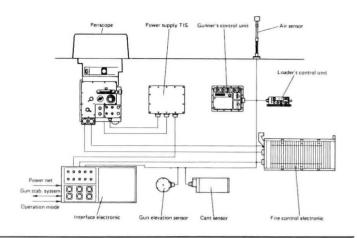
The sighting system design allows for full utilisation of the fire-control system by day or night and in haze, fog or smoke. All the gunner has to do

is acquire the target with his sight, find its range with the laser rangefinder and then, while the computer continuously calculates the corrected superelevation and lead angles from the manually and automatically input fire-control parameters, keep his LOS on it until the firing circuit is enabled and commence firing with the selected armament.

Status: Production. Deliveries against an order from Greece for 200 (M48 MBT fit) started in 1992 and an option exists on a further 200 systems for Greece, also for modernised M48 MBT's.

Manufacturer: Atlas Elektronik GmbH, Sebaldsbrücker Heerstrasse 235, D-2800 Bremen 44, PO Box 44 85 45, Federal Republic of Germany. Telephone: (421) 457-0 Telex: 2457460 Fax: (421) 457 2900

Schematic layout of Atlas Elektronik MOLF Fire-Control System for M48 MBT



Atlas Elektronik Integrated Operating and Display System – IBAS

Development/Description

The IBAS (acronym based on the German name of the system) system is designed as an all-purpose modular integrated operating and display system for use in all types of armoured fighting and civil defence vehicles. Variants are currently being developed for the Federal German Army's Marder 2 MICV. Because of the modularity, the IBAS assembly can be configured for other weapon systems. In such cases the modules are combined as required, are installed in one or more frame modules and integrated specifically for the system concerned.

Designed for centralised control of various functions and fire-control systems, the IBAS comprises a series of standardised sub-assembly modules housed in a compact mainframe and interfaced to the fire-control and vehicle power networks. Similar units are used for both the commander's and gunner's stations.

The IBAS subsystem assemblies are:

- frame module which is used to hold the individual modules and contains the various interfaces
- (2) sight control module which provides for the standardised operation of all sights
- (3) mode control module for displaying the modes of operation, ammunition types and tactical data on a high resolution 101.6 × 127 mm programmable full-colour LCD display facility. This also acts as the central control module for operating the fire control system and incorporates soft operating keys situated around the display
- (4) I/O module that acts as an input/output operating unit for special system functions such as the testing and relay of both the system and adjusting of its parameters.

Each individual module is equipped with built-in test facilities which can be activated and interrogated via the RS 485 interfaces.

A typical fit for an MBT may include:

(a) Commander's station
 one frame module with:
 one sight control module
 one mode control module
 one frame module with:

one I/O module

(b) Gunner's station one frame module with:

one sight control module one mode control module

one frame module with:

one I/O module

A typical fit for a MICV would include:

Commander's station

one frame module with: one sight control module one mode control module

one frame module with: one I/O module

Status: Development.

Manufacturer: Atlas Elektronik GmbH, Sebaldsbrücker Heerstrasse 235, D-2800 Bremen 44, PO Box 44 85 45, Federal Republic of Germany. Telephone: (421) 457-0 Telex: 2457460 Fax: (421) 457 2900

Atlas Elektronik Vehicle Integrated Command and Information System – IFIS

Development/Description

The IFIS (acronym based on the German name of the system) system is designed to link armoured vehicles of varying types up to the battalion level with higher echelon command and control systems.

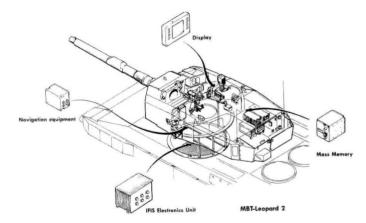
IFIS comprises the following subsystems:

- a display unit for the display of maps, tactical situation overlays and text in colour with soft-key and position elements
- (2) a vehicle navigation unit for accurate determination of direction and position
- (3) a large microprocessor memory for storing the digital map data
- (4) an electronics unit with communications processor and standard equipment interfaces for the vehicle systems and the radio

(5) the use of ADA software.

The main tasks of the IFIS are to reduce the work-load of the vehicle/unit commander and his subsequent reaction time by simplifying the following recording/implementation subject areas:

- (a) friendly dispositions
- (b) enemy dispositions
- (c) reports and orders
- (d) communication
- (e) battlefield reconnaissance
- (f) coordinating battlefield engagements.



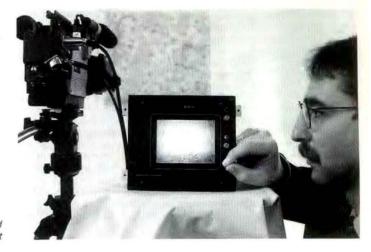
General arrangement drawing showing installation of the IFIS system in a Leopard 2 MBT

This is achieved by the:

- (i) display of a digital map with tactical overlays
- (ii) display of reports and orders text
- (iii) automatic transfer of battlefield information via the radio network
- (iv) menu-controlled guidance of the system display by the operator.

Status: Development.

Manufacturer: Atlas Elektronik GmbH, Sebaldsbrücker Heerstrasse 235, D-2800 Bremen 44, PO Box 44 85 45, Federal Republic of Germany. Telephone: (421) 457-0 Telex 2457460 Fax: (421) 457 2900



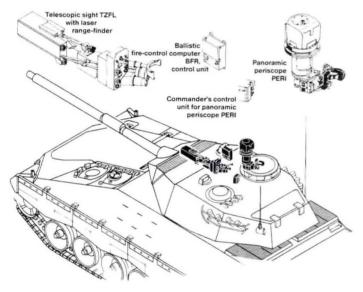
Display unit of Atlas Elektronik Vehicle Integrated Command and Information System (IFIS) under test

Zeiss AFS-4 AFV Gun-Laying and Fire-Control System

Development/Description

The concept of the Zeiss AFS-4 fire-control system lies in the functional separation between the gunner's station and the commander's station.

The functions of both, however, can be joined via the type of operation logic and are divided into operating stages. The system is designed to operate under the conditions of the Hunter-Killer concept.



Key components of Zeiss AFS-4 Gun-Laying and Fire-Control System installed in Thyssen Henschel TH 301 turret

The main subsystems are:

- gunner's TZFL monocular telescopic sight with × 8 magnification and 10° field-of-view integrated with an Nd-YAG laser rangefinder operating at 1.06 μm wavelength. The maximum range capability is 9995 m with an accuracy of ±5 m. The sight is mechanically linked to the independently stabilised main weapon. Optical servo-components are located within the TZFL which are controlled via servo-loops to keep the Line-Of-Sight (LOS) on the target with a high degree of accuracy even when the vehicle is moving
- commander's PERI primary stabilised monocular panoramic periscope sight and control unit, through which he can either have an overall observation independent of the turret position or be slaved to the FCS engagement. The latter allows him to overrule the gunner and conduct the firing himself via his control handle.

The sight has two switchable magnifications of × 2 and × 8 with 30 and 8° fields-of-view respectively:

- commander's control handle
- gunner's computer control panel
- BFR ballistic fire-control computer.

Both the commander's and gunner's battle stations remain independent so that, if one fails, the functionability of the other is maintained, thus increasing the overall tactical value of the FCS.

All five operating modes are operable when the tank is stationary or mobile and with the turret in any position, without limitation.

In the case of failure of the electric power system, combat capability is maintained as the gunner's sight is mechanically linked to the gun. The ballistic data, dependent upon the range in elevation and azimuth, are manually input via numerators.

The system is also available with an optional thermal sight enhancing the bad weather and night operational capability of a fitted vehicle.

Status: Production. In service with undisclosed countries

Manufacturer: Carl Zeiss, Carl Zeiss Strasse, PO Box 1369/1380, D-7082 Oberkochen, Federal Republic of Germany.

Telephone: (07364) 20-2879 Telex: 71575133 Fax: (07364) 203855

INDIA

Bharat Electronics Tank Fire-Control System Mk 1A

Development/Description

Designed by the Bharat Electronics Tank Electronics Support Centre, Madras for use with the Vijayanta MBT as part of the Project Bison upgrade, the Tank Fire Control System Mk 1A (AL4420) features an improved sight mount and fire-control linkage to minimise the play between both the mount and the linkage and the 105 mm L7 main gun.

The object of these improvements is to minimise the loss of zeroing, improve the gunsight follow-up accuracy and reduce the non-repeating errors

Maximum permissible displacement of the Line-Of-Sight (LOS) is 0.15 mil with the sight movements limited to -7 to $+18^{\circ}$. A sight adaptor jacket allows the fitting of a day or night sight unit.

A Muzzle Reference System (MRS) is also fitted to check for and correct misalignment between the gun and sight axes caused by thermal deformation.

The MRS light source unit comprises a halogen lamp coupled to optical fibres and a yellow filter to produce a circular light beam. A deviation prism,

fitted in the current gunner's AFV No 30 Mk 1 sighting periscope, projects the formed light beam from the MRS mirror on to the sight graticule. The MRS control box has switches for both the heating element and the halogen lamp.

Status: Production. In service with the Indian Army (on Vijayanta MBTs).

Manufacturer: Enquiries to: General Manager (Exports), Bharat Electronics Limited, 'Trade Centre', 116/2 Race Course Road, Bangalore 560001, India

8650 BE IN Fax: (812) 265657/(812) 268410

Note: Bharat Electronics has also supplied a Tank Fire-Control System for the upgraded Indian Army T-55 MBTs fitted with a licence-built 105 mm L7 gun and an image-intensifying night sight for the gunner. No other details are available at present.

Bharat Electronics Tank Fire-Control System

Development/Description

The Tank Fire-Control System Mk 1B (AL4421) developed by the Bharat Electronics Tank Electronics Support Centre, Madras is a computerised follow-on to the Mk 1A for the Vijayanta MBT. It incorporates a Barr and Stroud Tank Laser Sight assembly (qv entry in Commanders' and Gunners' Day and Night Observation and Sighting Systems section)

The aim is to reduce the target engagement time cycle and increase the first round hit probability of both a moving tank engaging a static target and a static tank engaging a moving target at any speed. Night firing is possible with a night sight adaptor mounted on the existing infra-red assembly. If required the FCS can be adapted to fit any tank model.

The 105 mm L7 main gun can be fired using one of the following options: a) the complete FCS and its subsystems in either:

- i) 'autolay' mode with the gun driven directly by the Motorola MC6800 ballistic computer
- ii) 'stab' mode in which the gunner uses the existing GCE weapon power controllers to bring the aiming mark on to the target. The engagement time is about eight seconds against static targets and 10 seconds against moving targets
- iii) 'manual' mode whereby the gunner operates conventional weapon control back-up traverse and elevation handwheels to align the aiming mark with the target. Engagement time against static targets is better than 10 seconds in this mode.

Changeover between the modes is instant, with the computer generated aiming mark (an ellipse with a central dot) also displaying the target range as measured by the laser rangefinder.

- b) the 1.064 µm Nd-YAG laser rangefinder on its own by means of a unique look-up table in the sight graticule
- c) by reversion to use of the original coaxially mounted 12.7 mm (0.5 in) calibre ranging machine gun facility. This has a maximum range of 1800 m and fires three-round bursts of tracer ammunition.

A Muzzle Reference System (MRS) is integrated with the sight optics so that the gunner can align, within 10 seconds, the sight and gun axes without moving from his seat.

The subsystems which comprise the Mk 1B are:

- (a) tank laser sight
- (b) MRS light source assembly
- (c) MRS mirror assembly
- (d) improved sight mount
- (e) linkage fire-control
- (f) computer and power supply unit
- (g) control panel
- (h) tilt sensor assembly
- (i) traverse encoder assembly
- (j) elevation encoder assembly.

The fire-control and gun control systems are fully integrated, with both the system power supplies and the GCE weapon controller interfaces housed in the computer unit.

The computer is normally programmed for 105 mm APDS and HESH ammunition types but only requires simple software changes for new ammunition types. Cross-wind, line wind, ammunition charge temperature and barrel wear parameters have to be entered manually.

The alloy head of the sighting unit has been made deliberately shatterable so if it is hit by shell fragments or small-arms fire it breaks to protect the main sight. Movement limits of the sight mount, armoured hood and sector gear assembly are -7° in depression to +18° in elevation.

SPECIFICATIONS

DIMENSIONS	
Tank Laser Sight	343 × 305 × 514 mm
Ballistic computer and	
power supply unit	$230 \times 425 \times 350 \text{ mm}$
Tilt sensor assembly	$235 \times 170 \times 55 \text{ mm}$
Traverse encoder assembly	260 × 190 × 230 mm
Elevation encoder assembly	$100 \times 175 \times 135 \text{ mm}$
Control panel	$210 \times 225 \times 125 \text{ mm}$

Sight Mount.	Armoured	Hood	and	Sector	Gear	Assembly
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Sight mount	516 × 284 × 316 mm
Armoured Hood	$365 \times 256 \times 165 \text{ mm}$
Linkage Fire-Control	$1050 \times 85 \times 225$ mm

 $310 \times 150 \times 135 \text{ mm}$

Muzzle Reference System MRS light source assembly

MRS mirror assembly	$70 \times 90 \times 90 \text{ mm}$
WEIGHTS	
Tank Laser Sight	21.3 kg
Ballistic computer and	

22 ka power supply unit 5.5 kg Tilt sensor assembly Traverse encoder assembly 9.6 kg Elevation encoder assembly 0.8 kg Control panel 3.2 kg

Sight Mount, Armoured Hood and Sector Gear Assembly

Sight mount	15 kg
Armoured Hood	27 kg
Linkage Fire-Control	8.3 kg

Muzzle Reference System

MRS light source assembly	10 kg
MRS mirror assembly	0.45 kg

Gunner's Tank Laser Sight

MAGNIFICATION	× 9.4
FIELD-OF-VIEW	8.5°
LASER RANGEFINDER TYPE	Nd-YAG
WAVELENGTH	1.064 µm
OPERATING RANGE	300-9990 m
RANGE ACCURACY	±10 m (90% of shots)

Acquisition sight

MAGNIFICATION	\times 1	

Computer

MAX RANGE PROCESSING 9990 m RANGE PROCESSING

ACCURACY

10 m AMMUNITION TYPES HESH and APDS (others with

software changes) TRUNNION TILT 250 mils max TRUNNION TILT ACCURACY 0.25 mil GUN JUMP AND THROW-OFF preset **ELEVATION ACCURACY** 0.2 mil

TRAVERSE DISPLACEMENT

ACCURACY 0.02 mil CROSS-WIND 25 m/s LINE WIND 25 m/s AMBIENT AIR TEMPERATURE -20° to +55°C

Control system

BALLISTIC COMPUTATION

ACCURACY better than 0.1 mil

GUN POSITIONING

ACCURACY 0.2 mil

POWER SUPPLY 22-30 V DC vehicle system

Status: Pre-production. On order for the Indian Army (for Vijayanta MBTs).

Manufacturer: Enquiries to: General Manager (Exports), Bharat Electronics Limited, 'Trade Centre', 116/2 Race Course Road, Bangalore, India. Telephone: (812) 269897/263117/267322 Telex: (845) 2477 BE IN/(845) 8650 BE IN Fax: (812) 265657/(812) 268410

Note: Bharat Electronics is involved in developing the Tank Fire-Control System for the Arjun MBT project. Other than that the system is believed to be a further development of the above TFCS and includes a day/thermal night sight with integrated laser rangefinder, computer and various sensors. No other details are available.

INTERNATIONAL

Combat Vehicle Command and Control (CVC2)

Development/Description

The Combat Vehicle Command and Control (CVC2) programme is a joint research and development venture between the US Army, as represented by the US Army Tank-Automotive Command (TACOM) and the US Army Communications-Electronics Command (CECOM), and the Federal Republic of Germany to demonstrate the technology required for a semi-automated, integrated and interoperable Command, Control and Communications (C3) system for ground combat vehicles.

The CVC2 programme is basically designed to develop this C3 system for US Army and German MBTs and will give vehicle commanders real-time tactical displays and other data linked information to produce display maps of both friendly and enemy dispositions, logistics, diagnostics and prognostics.

The system will significantly enhance battlefield integration and allow synchronisation of manoeuvre force elements from the individual vehicle level up to and including the battalion level.

Further armour specific tactical data messages will be transmitted among terminals over the Single Channel Ground-to-Air System (SINCGARS) combat radio network.

The CVC² functionally is provided in either an M1A2 (modified) tank or a stand alone laptop computer. Communication is provided by two SINCGARS radios for both voice and data.

A militarised Lightweight Computer Unit (LCU) has been developed to

provide digital C³ information to other vehicles on the battlefield which do not have an integrated CVC² system but still require CVC² functionality.

A new communications protocol, the Multi-Designation Protocol (MDP), has been developed by CECOM to provide more reliable and efficient digital data communication between all CVC nodes.

Status: Technology demonstration development.

Manufacturer: Enquiries to: Commander, US Army Tank Automotive Command, Attn: AMSTA-RV, Warren, MI 48397-5000, USA.

Telephone: (313) 574-6160

ISRAEL

Astronautics FCS-10 Tank Fire-Control System

Development/Description

The FCS-10 Fire-Control System is designed to automate the M13A1 ballistic computer of M48/M60 series MBTs so that it can accept and utilise inputs from laser and/or optical rangefinding systems. The system comprises the following components:

- 1) laser rangefinder (with optional thermal sight unit)
- 2) M17 optical rangefinder
- 3) commander's control panel
- 4) gunner's control panel
- 5) M13A1 ballistic computer which mechanically drives the day sight and gun
- 6) FCS-10 Digital Interface Unit (DIU) servo control with integral 8-bit microprocessor that accepts information from the laser rangefinder, cant angle sensor and target rate sensor and, after calculating the gun elevation angle, passes it on to the ballistic computer to set the gun. It also controls the optional thermal sight unit and includes a Battle Range mode

7) interconnecting cable set.

In operation the FCS-10 receives range data from the laser rangefinder then, with the ammunition type pre-programmed, the system automatically calculates the gun elevation angle. Corrections for ambient air temperature, vehicle altitude, cross wind velocity, barrel wear and barrel jump are automatically included.

The operating range of the system is 500-4400 m with an accuracy of ± 10 m. The power supply required is the vehicle's own 24 V DC system.

Status: Production as required. In service with the Israeli Defence Force (on M48/M60 MBTs) and the Royal Thai Army (on M48A5 MBTs).

Manufacturer: Astronautics C.A. Limited, 23 Hayarkon Street, PO Box 882, IL-51261 Bnei Brak, Israel.

Telephone: (03) 5791555 Telex: 341294 Fax: (03) 5704404

Astronautics FCS-2010 Tank Fire-Control System

Development/Description

The FCS-2010 Fire-Control System is a more flexible version of the FCS-10 (qv) designed for use with the M48/M60 MBTs. The system comprises the following components:

- commander's control unit which inputs into the gunner's control unit
- 2) gunner's control unit which accepts information from the full range of sensors and the commander's control unit and then uses its integral digital computer to calculate the lead compensation and vehicle compensation

values for onward transmission to the M13A1 ballistic computer's mechanical servo section that drives the day sight and main gun. The gunner's unit also controls the thermal sight system. The ballistic computer calculation facilities are retained for backup fire-control purposes if the FCS-2010 becomes inoperable.

Status: Production as required.

Manufacturer: Astronautics C.A. Limited, 23 Hayarkon Street, PO Box

882, IL-51261 Bnei Brak, Israel.

Telephone: (03) 5791555 Telex: 341294 Fax: (03) 5704404

Astronautics FCS-20 Tank Fire-Control System

Development/Description

The FCS-20 Fire-Control System is designed to automate the aiming system of the Centurion MBT so that it can accept and utilise inputs from a laser rangefinder for day or night use. The system comprises the following components:

- 1) a fixed laser rangefinder
- 2) a gunner's night vision sight
- 3) gunner's control unit which accepts information from the laser rangefinder via the commander's control unit and manual parameter inputs from the gunner and commander in order to automatically calculate, using an integral digital computer, the gun-sight elevation angle according to the preselected ammunition type. This is then displayed and transmitted to the sight
- 4) a drive unit which is attached to the gunner's control unit and computer and transmits the calculated gun-sight angle to the day sight system and the range drum

- 5) commander's control unit which accepts information from the laser rangefinder and manual parameter inputs from the commander and passes the data on to the gunner's control unit where it is used by the computer in its calculations. The calculated gun-sight elevation is then displayed on a small panel
- 6) interconnecting cable set.

The operating range of the system is from 400-6000 m with an accuracy of ± 10 m. The power supply required is the vehicle's own 24 ± 6 V DC system.

An improved variant which includes both a cant angle and a target rate sensor is available, as is a more basic version of the FCS-20 with no commander's control unit.

Status: Production as required. In service with the Israeli Defence Force (on Centurion MBTs).

Manufacturer: Astronautics C.A. Limited, 23 Hayarkon Street, PO Box 882, IL-51261 Bnei Brak, Israel.

Telephone: (03) 5791555 Telex: 341294 Fax: (03) 5704404

Astronautics FCS-30 Tank Fire-Control System

Development/Description

The FCS-30 Fire-Control System has all the features of the FCS-20 (qv) but accepts the range input from a hand-held laser rangefinder used by the commander rather than the fixed system used by the gunner. When this information has been obtained the FCS-30 computer calculates the firing solution, according to the type of ammunition selected, and sets the gun's angle of elevation.

The FCS-30 has been fitted to the Israeli Defence Force's upgraded T-54 and T-55 series MBTs, and can be used for Type 59 MBTs.

A variant with an integrated laser rangefinder in the gunner's sight is also available.

Status: Production as required.

Manufacturer: Astronautics C.A. Limited, 23 Hayarkon Street, PO Box 882, IL-51261 Bnei Brak, Israel.

Telephone: (03) 5791555 Telex: 341294 Fax: (03) 5704404

Astronautics FCS-40 Tank Fire-Control System

Development/Description

The FCS-40 has been designed to upgrade the fire-control system of the AMX-13 and M41 light tanks armed with 75 mm, 76 mm or 105 mm main guns and is essentially the same as the FCS-20 (qv) except for the following configuration changes:

- 1) Variation A
- a) the original gunner's optical sight unit is retained
- b) the fixed laser rangefinder is replaced by a hand-held commander's laser rangefinder unit
- c) the drive unit sets the graduation line at the correct angle of elevation in the sight

2) Variation B

a) the original gunner's sight unit is replaced by a new system which incorporates a \times 8 magnification laser rangefinder elbow and a \times 8 magnification passive night vision elbow

b) the drive unit sets the graduation line at the correct angle of elevation on both elbows.

Both the variations can also include a cant angle sensor and a target rate

Status: Production as required. In service with unspecified countries.

Manufacturer: Astronautics C.A. Limited, 23 Hayarkon Street, PO Box 882, IL-51261 Bnei Brak, Israel.

Telephone: (03) 5791555 Telex: 341294 Fax: (03) 5704404

Astronautics FCS-50 Tank Fire-Control System

Development/Description

The FCS-50 has been designed to upgrade the fire-control systems of the M4 and M51 Sherman tanks and the M41 light tank is essentially the same as the FCS-20 (qv) except for the following configuration changes:

- 1) Variation A
 - a) the original M20 gunner's sight is retained
- b) the fixed laser rangefinder is replaced by a hand-held commander's laser rangefinder unit
- c) the drive unit drives the ballistic unit to the computed elevation angle
 - 2) Variation B
- a) the original gunner's sight is replaced by a new system which incorporates a \times 8 magnification laser rangefinder elbow and a \times 8 magnification passive night vision elbow
- b) the drive unit drives the ballistic unit to the computed elevation angle

3) Variation C

- a) the original gunner's sight is replaced by a new system which incorporates a \times 8 magnification laser rangefinder elbow and a \times 8 magnification passive night vision elbow
- b) the original commander's sight is replaced by a new system which incorporates a \times 8 magnification day elbow and a \times 8 magnification passive night vision elbow
- c) the drive unit drives the ballistic unit to the computed elevation angle.

Status: Production as required.

Manufacturer: Astronautics C.A. Limited, 23 Hayarkon Street, PO Box 882, IL-51261 Bnei Brak, Israel.

Telephone: (03) 5791555 Telex: 341294 Fax: (03) 5704404

Astronautics FCS-61 Tank Fire-Control System

Development/Description

The FCS-61 has been designed to upgrade the fire-control systems of the Israeli Army M60A3 MBTs. This is done by replacing the original gunner's control unit, ammunition selection units and M21 computer functions with identical gunner's and commander's digital control units that add extra functions and capabilities.

The new control units provide parameter feed and displays which are connected to the remaining original fire-control subsystems by four cables. No machining or welding operations are required for the installation.

In operation the FCS-61 receives inputs from the fire-control sensors to accurately calculate the superelevation and horizontal deflection corrections. It also filters the wind fluctuation parameter and offers remote range measuring by the gunner.

Data on up to 10 different ammunition types can be stored with extremely fast reaction to provide the 'battle range' information on each type.

The improved target tracking capabilities allow automatic detection of stationary/moving vehicles. The commander can also use a hand held rangefinder system to input target range data into his control panel.

The approximation range of the system is from 200 to 2000 m, with a

The operating range of the system is from 200 to 9990 m with a resolution of ± 10 m. The power supply required is the vehicle's own 24 ± 6 V DC system. Weight of the commander/gunner's control unit is 5 kg and dimensions $278 \times 130 \times 151$ mm (×2).

Status: Production. In service with the Israeli Army (on M60A3 MBTs).

Manufacturer: Astronautics C.A. Limited, 23 Hayarkon Street, PO Box 882, IL-51261 Bnei Brak, Israel.

Telephone: (03) 5791555 Telex: 341294 Fax: (03) 5704404

Elbit/EL-OP Tank Fire-Control Systems

Development/Description

The Elbit/EL-OP Tank Fire-Control System (TFCS) started life as the advanced digital ballistic computer system for the Merkava Mk 1 MBT. This was soon expanded to a full solution integrated Tank Fire-Control System of modular design, adaptable for use in a number of light and medium tanks and MBTs.

The following fire-control systems are available:

Matador Mk I – for M48, M60 and Centurion MBTs. A direct replacement system for the original optical sight and mechanical computers of these MBTs. It provides an automatic digital day/night fire-control solution capability with cant angle, angular velocity and meteorological (wind velocity, ambient temperature and altitude) mast sensors. It is available with both thermal imaging or image intensifier night vision options.

Matador Mk II – operationally equivalent to the Matador Mk I but designed for European MBTs such as the AMX-30, Leopard 1, T-55, T-62 and similar vehicles as well as for tanks with no ballistic drive system.

Matador Mk III – special configuration for the Merkava Mk II MBT. Several features of this design have been incorporated into the Knight family.

Knight Mk I – for M48, M60 and Centurion MBTs. It equips these vehicles with an electrically powered head mirror that retains the mechanical operation of the sight through its original ballistic drive, operating in the degraded emergency mode. Advanced system control loops allow a fire-on-the-move capability using a coincidence algorithm. It can easily be integrated into the existing electrohydraulic turret power controls of the M48A5, M60A1, M60A3 and T-72.

Knight Mk II – an advanced two-axis stabilised line-of-sight capable system for new build MBT programmes and fitted with sophisticated manmachine interfaces and matching image processing capabilities.

Lansadot Mk I — a compact modular and fully automatic fire-control system that features a single reticle for day and night lasing and aiming. The Mk I can be integrated with a linkage rod or be used with the oscillating turrets of the AMX-13 and Kürassier light tanks, as well as AMX-30, M41, LAV, T-55 and light turrets. The system contains cant angle, angular velocity and meteorological (wind velocity, ambient temperature and altitude) sensors but, because of the compactness of its peritelescope, does not include an integral thermal imaging telescope option. However, it has been successfully integrated with the externally mounted, modular IRIS thermal imaging telescope.

Lansadot Mk II – similar to the Lansadot Mk I but contains an electrically driven and mechanically independent head mirror assembly. Its peritelescope also allows integral installation of various thermal imaging systems, in 60 or 120 element configurations, as well as an image intensifier night vision assembly.

Lansadot Mk III – a direct replacement system for the ageing M32 and M36 periscopes of US Army and US Marine Corps M60, LAV type and AAV vehicles. It can be supplied with a mechanical and electrical head mirror assembly, thermal imaging systems, in 60 or 120 element configurations, as well as an image intensifier night vision assembly.

Lansadot Mk IV – this features all the day and night characteristics of the Lansadot Mk III but with the addition of a two-axes stabilised line-of-sight capability and a fire-on-the-move function.

The Matador Mk II, Lansadot Mk II and Lansadot Mk III units can also be integrated with a gun stabilisation system to enable fire-on-the-move functions by using a head mirror that is stabilised in elevation and the turret stabilised in traverse (that is similar to the system used on the American M1A1 Abrams MBT).

The Matador family has the same basic building blocks but with more sophisticated components. The digital ballistic computer has inputs from a moving target velocity sensor, a cant angle sensor and a meteorological

sensor pack (with crosswind velocity, air pressure and ambient air temperature sensing devices). It can also have up to three ammunition selector units fitted for the gunner, commander and loader as well as the normal gunner and commander control units. Main data inputs, however, come from the gunner's periscope head assembly with its laser rangefinder elbow and image intensifier elbow.

The systems have day and night target acquisition and target tracking with fast firing capabilities built in to give a high first-round hit probability at extended ranges. Engagements can be against stationary or moving targets whilst the firing platform itself is stationary, against moving, or stationary



Matador Mk 1 fire-control system installed in Centurion MBT

targets while the firing platform is itself moving, or against short, medium or long range targets using the gunner's image intensifier elbow.

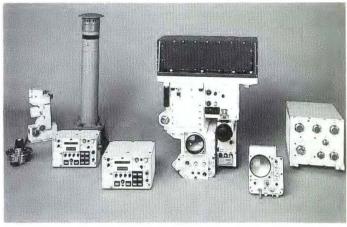
Status: Matador, Knight and Lansadot families of TFCS are in production. In service with Israel and other unspecified countries.

Manufacturers: Elbit Ltd, Advanced Technology Centre, PO Box 539, IL-31053 Haifa, Israel.

Telephone: (04) 315315 Fax: (04) 550002

EL-OP Electro Optics Industries Ltd, Advanced Technology Park, Kiryat Weizmann, PO Box 1165, IL-76110 Rehovat, Israel.

Telephone: (08) 386221 Telex: 381344 Fax: (08) 386237



Lansadot Mk II tank fire-control system

Elbit/EL-OP Knight Family of Advanced Tank Fire Control Systems (ATFCS)

Development/Description

The Israeli companies of Elbit and EL-OP have co-developed and produced the Knight Mk I modular ATFCS as a retrofit/upgrade package for the M48, M60 and Centurion MBTs. Its modular nature also allows easy adaption to other turret types with the minimum of interfacing changes. A Knight Mk II with more sophisticated systems is available for new build MBTs.

Knight is fully integrated with the turret weapon control/drive system and actively controls the turret dynamics. It has stabilised Line-Of-Sight (LOS), a short target acquisition cycle, a day and night operation capability and a high hit probability for stationary and on-the-move engagements.

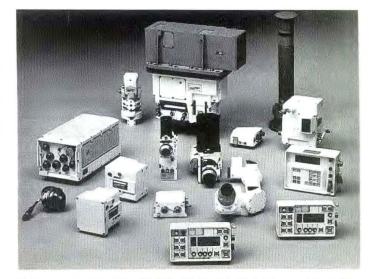
The major modes of operation are:

- 'stabilised' where the gun axis is slaved to the LOS
- b) 'slave' where only the gunner's LOS is slaved to the gun axis.

The main components of the complete Knight Mk I system are:

- 1) ballistic computer
- 2) gunner's control unit
- 3) commander's control unit
- 4) cant angle sensor
- 5) pitch angle sensor
- tracking unit
- main body and mirror head of gunner's periscope
- 8) laser rangefinder elbow
- 9) night vision image intensifier elbow
- 10) laser rangefinder electronic unit
- 11) commander's optical relay
- 12) gunner's service unit
- 13) mast for meteorological sensors
- 14) mechanical output unit.

Status: Production. In service with Israeli Army on M60 and Merkava series MBTs.



Main components of the Elbit/EL-OP Knight Mk I Advanced Tank Fire-Control System (ATFCS)

Manufacturers: Elbit Ltd, Advanced Technology Centre, PO Box 539, IL-31053 Haifa, Israel.

Telephone: (04) 315315 Fax: (04) 550002

EL-OP Electro Optics Industries Ltd, Advanced Technology Park, Kiryat Weizmann, PO Box 1165, IL-76110 Rehovot, Israel.

Telex: 381344 Fax: (08) 386237 Telephone: (08) 386221

Elbit/EL-OP Lansadot Family of Armoured Vehicle Fire-Control Systems

Development/Description

The Israeli companies of Elbit and EL-OP have co-developed and produced the Lansadot compact modular fire-control family (Mk I, Mk II, Mk III and Mk IV) for updating various types of AFVs. No vehicle modifications are required for M41 light or M47 medium tanks, and only minor modifications for the AMX-13 light tank, AMX-30 MBT, Sherman medium tanks (all models), Saladin armoured car, T-54/T-55 MBTs, Light Armoured Vehicles (LAVs) and Armoured Personnel Carriers.

Depending upon model the Lansadot can be capable of day and night

observation, target identification, laser rangefinding and accurate firing against stationary and moving targets.

The main components are:

- a) gunner's peritelescope sight with integrated laser rangefinder, passive image intensifier night vision elbow, and unity prism for daylight observation purposes
- b) ballistic computer system with computer; computer control unit and cant angle sensor. The computer provides a single reticle for day/night lasing and aiming and automatically compensates for ballistic parameters
- c) moving target velocity sensor
- d) optional commander's control panel
- e) optional meteorological sensor package
- f) interconnecting cable set

-18

80

+5 m

+30 mils

72 km/h

+20

0 to 70 mils

SPECIFICATIONS (Lansadot Mk I) Gunner's Peritelescopic Sight ELEVATION

DEPRESSION DAY CHANNEL FIELD-OF-VIEW

× 8 magnification

× 1 magnification NIGHT CHANNEL FIELD-OF-VIEW

× 7 magnification LASER RANGE

LASER RANGE ACCURACY

Computer Compensation Ranges

(day and night) LINE-OF-SIGHT horizontal deflection superelevation CANT ANGLE

MAX MOVING TARGET VELOCITY

CROSSWIND

±19 km/h AMBIENT AIR TEMPERATURE -19 to +69°C ALTITUDE -400 to +4500 m

Status: Production. In service with unspecified countries

Manufacturers: Elbit Ltd, Advanced Technology Centre, PO Box 539,

IL-31053 Haifa, Israel.

Telephone: (04) 315315 Fax: (04) 550002

+35° (optional +60° version for anti-aircraft application)

40° × 14° 300 to 9900 m

Lansadot Mk I fire-control system, gunner's peritelescope in night configuration

EL-OP Electro Optics Industries Ltd, Advanced Technology Park, Kiryat

Weizmann, PO Box 1165, IL-76110 Rehovot, Israel. Telephone: (08) 386221 Telex: 381344 Fax: (08) 386237

Elbit/EL-OP Matador Family of Tank Fire-Control Systems

Development/Description

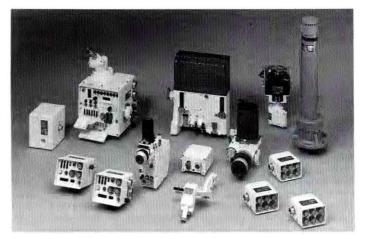
Based on an improved M32 periscope with optics that can withstand laser radiation damage, the Matador Mk I AFV fire-control system is a fully automatic system fitted with a rotating wedge module for the insertion of ballistic compensations in deflection using a moving view ballistic computercontrolled device and a higher accuracy rotating mirror servo mechanism.

The aiming subsystem package consists of the gunner's modified M32 periscope with the day/night moving view ballistic computer-controlled deflection system, an EL-OP mini-laser rangefinder used as a direct substitute for the M32 day elbow and an optional second generation image intensifier night sight elbow.

The moving view system has only a single graticule for both the ranging and aiming processes, with the rotating wedge module moving the scenery and not the graticule so that it always remains in the centre of the fieldof-view. Thus the gunner always ranges, aims and fires the weapon with the graticule at the centre of the field-of-view where the resolution is best.

The computer and sensor subsystem package consists of: the digital electronic elevation and deflection compensation ballistic computer; a manual environmental data input insertion unit to the ballistic computer (with an optional meteorological sensor); the commander's control unit with an optional optical relay to the commander, or a conversion kit for his existing optical rangefinder that includes a range display and a rotating wedge module for automatic insertion of ballistic compensation to enable him to conduct weapon firing from his position; the loader's ammunition selection unit; a cant angle sensor; and an angular velocity sensor.

Matador Mk II (for European MBT designs such as the AMX-30, Leopard 1, T-55 and T-62) and Matador Mk III (for the Merkava Mk II MBT) systems have also been built.



Main components for Matador Mk I fire control system for M48 or M60

Status: In production. In service on Merkava Mk 2 MBT (Matador Mk III) and modernised T-54/55 and T-62 MBTs, (Matador Mk II, from 1984 onwards).

Manufacturers: Elbit Ltd, Advanced Technology Centre, PO Box 539, IL-31053 Haifa, Israel

Telephone: (04) 315315 Fax: (04) 550002

EL-OP Electro Optics Industries Ltd, Advanced Technology Park, Kiryat Weizmann, PO Box 1165, IL-76110 Rehovot, Israel.

Telephone: (08) 386211 Telex: 381344 Fax: (08) 386237

SPECIFICATIONS Gunner's periscope

LINE-OF-SIGHT TRAVEL elevation depression deflection **DEFLECTION ACCURACY DEFLECTION SPEED** BORESIGHTING deflection evaluation ranging and aiming

Night sight MAGNIFICATION FIELD-OF-VIEW RESOLUTION POWER SUPPLY regular emergency

22 18 +40 mils 0.1 mils 40 mils in 1.5 s

electronic mechanical single graticule

0.2 mils at 3×10^{-3} fl

24 V DC vehicle two 2.7 V BA/1567 batteries Meteorological sensor (optional)

CROSSWIND SENSOR AIR TEMPERATURE SENSOR AIR PRESSURE SENSOR

Cant angle sensor ANGULAR RANGE ANGULAR ACCURACY **DIMENSIONS**

Mini-laser rangefinder MAGNIFICATION FIELD-OF-VIEW OPERATIONAL RANGE MIN RECEIVER RANGE GATE

POWER SUPPLY WEIGHTS control box rangefinder unit DIMENSIONS control box rangefinder unit

-19 to +19 m/s -20 to +70°C -400 to +2900 m

±15° 0.15° 153 × 173 × 135 mm

 \times 8 300-9990 m adjustable from 300-6000 m continuously 24 V DC vehicle

1.7 kg 4.5 kg

150 × 130 × 90 mm $310 \times 260 \times 100 \text{ mm}$ **Ballistic computer** OPERATION RANGE RESOLUTION **ELEVATION COMPENSATION ANGLES** DEFLECTION COMPENSATION ANGLES

JUMP COMPENSATION

GUN WEAR

BORESIGHT RANGE

200-9990 m 10 m

-1 to 99

±40 mils ±5 mils (for each type of ammunition) 8 eighths, 0.25 mm for each

eighth

200-9990 m

AMMUNITION CHOICE

COMPUTATION AND CONTROL ACCURACY

Loader's ammunition unit

DIMENSIONS Angular velocity sensor MAX ANGULAR VELOCITY TRACKING TIME

DIMENSIONS

six types (typically two types APDS, two types APFSDS, HEAT

And HEP)

0.1 mil

150 × 80 × 115 mm

4º/s

290 × 130 × 130 mm

EL-OP BAT-30 Computerised Fire-Control System

Development/Description

The BAT-30 computerised modular fire-control system for armoured vehicles such as the T-series, AMX-30 and Centurion MBTs and Light Armoured Vehicles (LAVs) is electrically interfaced to the vehicle and comprises a gunner's periscopic body assembly which is mounted in the turret with a head mirror unit on top and bolted to it.

The sight includes three viewing channels, a unity sight window with a 50 by 22° field-of-view for large field-of-view observation purposes together with a \times 8 mini-laser rangefinder system with an 8° field-of-view and a \times 7 night elbow with a minimum 7.5° field-of-view

A ballistic computer unit consisting of the computer body, various sensors and their control boxes complements the sight system within the turret

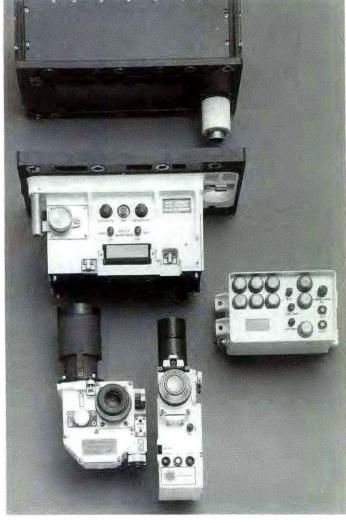
A resolver is mounted on the gun trunnion to measure the gun elevation angle and another resolver is mounted on the head mirror shaft to measure the mirror elevation angle. The difference between the two angles is nulled by the computer.

The BAT-30 has a single graticule for both ranging and aiming that always remains at the centre of the field-of-view. A rotating wedge module which is part of the body assembly moves the scenery and not the graticule. Thus the gunner always ranges, aims and fires with the graticule at the centre of his field-of-view where the resolution is best.

Two optional additions to the system are a commander's observation unit consisting of a head mirror with interchangeable day and $\times\,7$ night elbows, and a second generation unity passive image intensification bi-ocular night viewer with a minimum 35° field-of-view mounted in the vehicle driver's hatch cover

CDE	CIE	104	TIO	NIC
SPE	CIF	ICA	110	142

SPECIFICATIONS		
Unit	Magnification	FOV
GUNNER'S PERISCOPE		
unity sight	× 1	50 × 22°
MINI-LASER RANGEFINDER	× 8	8°
night elbow	×7 ±10%	min 7.5°
COMMANDERS		
OBSERVATION DEVICE		
night elbow .	×7±10%	min 7.5°
driver's night viewer	× 1 ±10%	min 35°
LINE-OF-SIGHT TRAVEL (IN		
ACCORDANCE WITH		
PERISCOPIC MOUNTING		
SURFACE)		
superelevation	-1 to +99 mils	
deflection	-40 to +40 mils	
elevation range	-10° to +20°	
OPERATIONAL RANGES		
mini-laser rangefinder display	300-9990 m	
boresight ranging	400-5000 m	
altitude (manual)	-400 to +6900 m	
boresight adjustment	-10 to +10 mils	



Main components of EL-OP BAT-30 computerised fire-control system

Status: In production. In service with unidentified countries.

Manufacturer: EL-OP Electro Optics Industries Ltd, Advanced Technology Park, Kiryat Weizmann, PO Box 1165, IL-76110 Rehovot, Israel. Telephone: (08) 386211 Telex: 381344 Fax: (08) 386237

EL-OP Red Tiger Tank Fire-Control System

The modular Red Tiger tank fire-control system is designed primarily for the upgrading of T-series and Centurion MBTs. If required, however, it can be adapted to fit other MBT models with a minimum of modifications.

Description

The main components of Red Tiger comprise:

- a) gunner's peritelescope sight with elecrically driven head mirror, sight body assembly, mini-laser rangefinder and optional thermal or passive image intensifier night vision elbow
 - b) commander's display unit for day/thermal sight
- c) ballistic computer group comprising the computer and accessory sensor package
 - d) interconnecting cable set.

The first round hit probability using 105 mm M735 APFSDS ammunition and a Red Tiger TFCS is 67 per cent at 2000 m range.

SPECIFICATIONS

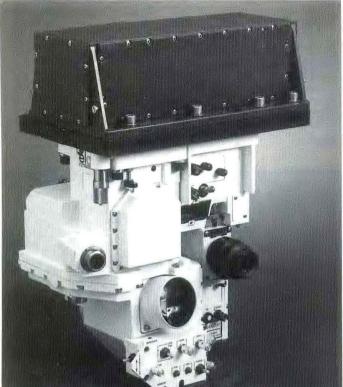
ELEVATION COVERAGE -10° to +20° COMPENSATION ANGLES -1 to +99 mils elevation ±40 mils (day)

deflection Day sight

FIELD-OF-VIEW

x 1 magnification 24.5 × 21.5° × 8 magnification

LASER OPERATIONAL RANGE 300-9900 m



Status: Pre-production. The system has undergone prototype trials in a

Manufacturer: EL-OP Electro Optics Industries Ltd, Advanced Technology Park, Kiryat Weizmann, PO Box 1165, IL-76110 Rehovot, Israel. Telephone: (08) 386211 Telex: 381344 Fax: (08) 386237

EL-OP Red Tiger tank fire-control system

Israel Aircraft Industries Howitzer Advanced Fire-Control System (HAFCS)

Development/Description

The HAFCS is a set of displays, controls, computers, communication and navigation equipment that was developed by Israel Aircraft Industries MBT Systems & Space Technology Electronics Division as an upgrade kit to the Israeli Army's conventional M109 series 155 mm self-propelled howitzers to increase their mission capability by an order of magnitude, whilst considerably improving their survivability. With minor changes to the system, HAFCS can easily be adapted for any other self-propelled

The modular system contains the following subsystems for the M109 application:

- Central Control Unit (CCU)
- (2) Two Battle Station Operation & Display Units
- Commander Display Unit (CDU) (a)
- Gunner Control & Display Unit (GCDU) (b)
- (3) Sensors
 - Muzzle Velocity Radar (MVR) (a)
 - Shot Sensor (SS) (b)
 - Tube Temperature Sensor (TTS) (C)
- (4) Power Conditioning Unit (PCU)
- (5) Tube Temperature Monitor
- (6) Communication Interface to Fire Direction Centre (CCI).

The HAFCS allows accurate commands to be transmitted to the howitzer

via a digital data link and be presented to the vehicle commander and gunner on their respective displays, at their battle stations.

Displayed status data aids the commander to make real-time decisions. The manual work load is reduced to enable rapid and precise gun laying by the gunner's use of an analogue presentation for laying the gun. The displayed gun angle is adjusted until it superimposes the displayed command angle, providing a procedure for rapid gun laying.

The HAFCS sensors automatically feed data into the system for real-time display of munition shock status, barrel information, thermal status and muzzle velocity to enable the commander to make early and timely decisions regarding mission activity as well as on-line correction of gun laying.

The onboard navigation equipment also enables the vehicle to 'shootand-scoot', moving from position to position with minimal time between engagements whilst simultaneously being able to use the dynamic reference unit (inertial) positional data for laying the gun and reporting its position to the FDC

The HAFCS allows the vehicle to deploy without terrain constraints whilst operating at full operational capability during day or night and under all atmospheric conditions.

Status: Production. In service with Israeli Army.

Manufacturer: Enquiries to: Israel Aircraft Industries Ltd. MBT Systems and Space Technology, Director of Marketing, POB 105, IL-56000 Yehud Industrial Zone, Israel,

Telephone: 972 3 355221, 972 3 5365236 Telex: 341450 MBT IL Cable: ISRAVIA Fax: 972 3 5365205

ITALY

Galileo TURMS Laser Tank Fire-Control System

Development/Description

The Tank Universal Reconfigurable Modular System (TURMS) third generation day/night laser fire-control system is designed for use with the IVECO FIAT/OTO Melara consortium C1 MBT but it can also be used as an upgrade package with suitable modifications for other tank types such as the Leopard 1. In this case it is known as the TURMS RXL.

For the VCC-80 infantry combat vehicle Officine Galileo has provided a TURMS package incorporating a thermal night viewing capability plus an additional unity direct view facility in the gunner's sight. The maximum elevation of both his and the commander's head mirror assemblies has also been increased from +20 to +60° in order to allow air defence engagements using the vehicle's 25 mm Oerlikon-Contraves KBA cannon.

For the B1 Ariete 8 × 8 wheeled tank destroyer, light intensifiers are used in the TURMS-type commander's sights which are then integrated with a SEPA-designed computerised fire-control system.

Further fits are envisaged for the TURMS equipment family. These include the use of the RXL gunner's sight variant with a lateral sight head arrangement as part of an upgrade package for the Italian Army's Leopard 1A1 MBTs, and the adoption of a daylight only version of the SP-T-694 with a 60° elevation capability by OTO-Melara for use on its private venture Otomatic 76 mm self-propelled air defence gun, with a fire control system based on the Italian armed forces standard MARA microprocessor made by Alenia.

The system comprises the following components:

1) a commander's SP-T-694 stabilised binocular panoramic sight with a 16-bit digital microprocessor for use with × 2.5 and × 10 magnification day channels that have, respectively, 20° and 5° fields-of-view and a single × 6 magnification 8° field-of-view third generation light intensification night vision channel. The operator can change channels at the push of a button with no loss of alignment between the various fixed and moving optical elements

- 2) a gunner's monocular periscopic laser sight system with:
 - a) a common primarily stabilised head mirror
 - b) a \times 10 magnification day visual channel with a 5° field-of-view
- c) the Officine Galileo VTG-120 modular parallel scanned thermal imaging unit variant operating in the 8-14 IR μm waveband and featuring a 240 line green/black CRT display with a dual field-of-view capability, $1.1\times2.2^{\circ}$ (narrow) and $3.3\times6.6^{\circ}$ (wide). Typical thermal imaging recognition range is 2000 m with the CRT image presentation being remotely monitored on a separate TV display alongside the commander's sight if required
- d) an MTL-8 Nd-YAG 1.064 μm wavelength laser transceiver module with a 10 000 m maximum range
- 3) an OTO Melara or Marconi Italiana ballistic digital computer which performs all the fire computations, controls the turret servo-mechanisms and manages the operation of all the ballistic units (optical sight, laser rangefinder) and the sensors. It also permits the reconfiguration of system operation from the automated level to backup manual modes in the case of partial failures. The ballistic computation range is from 300 to 4000 m
 - 4) meteorological, tank attitude, and powder temperature sensors
 - 5) gunner's control panel
 - commander's control panel 6)
 - 7) loader's control panel
 - 8) muzzle reference set
 - 9) interconnecting cable set.

The TURMS system can be used even on the move against stationary and moving targets in both day and night conditions to provide a very high first-round hit probability

Status: Production. Being delivered to the Italian Army (for use on the C1 MBT, B1 tank destroyer and the VCC-80 infantry combat vehicle). As of February 1993 only the B1 Centauro 8×8 105 mm tank destroyer was in production



TURMS Tank Laser Fire-Control System components

Manufacturer: Officine Galileo SpA, Via Einstein 35, IL-50013 Campi Bisenzio, Florence, Italy

Telephone: (55) 89501 Telex: 570126 Fax: (55) 8950600

Galileo ATREOS Tank Laser Fire-Control System

Development/Description

The ATREOS is designed as a minimal configuration fire-control system for new build armoured vehicles such as the SK-105 Kürassier tank destroyer and the OTO Melara T 20, T 60/70 and T 90 series turrets. It can also be used to retrofit M48 and M60 tanks.

The system comprises the following components:

- 1) a gunner's day/night +20 or +60° elevation sight assembly with:
- a) mirror head system that is mechanically linked to the main armament. Optional features include unity vision capability and MRS switching.

Future development may include the fitting of either an electric-servo elevation unit or full stabilisation system and the introduction of input/output germanium mirrors

- b) \times 10 magnification monocular day sight with the capability for displaying a computer controlled graticule in the field-of-view. A manual graticule is also fitted for system back-up purposes
- c) modular third generation image intensifier night sight with the capability for displaying a computer controlled graticule in the field-of-view.

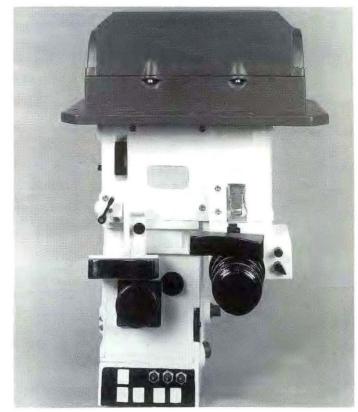
Expected future development may include the optional replacement of the image intensifier module with either a 3-5 or 8-14 µm waveband thermal imaging system

- d) GEC-Ferranti Defence Systems Type 520 Nd-YAG 1.064 µm wavelength laser rangefinder with a range capability of 300-9995 m and an accuracy of ±5 m
- e) CRT module and control unit which controls the optical units and generates the control signals for the layer.

Expected future development for this is the fitting of a CRT which generates a computer controlled laying graticule for the sights

- 3) a digital ballistic computer unit which includes a keyboard and power supply. In its basic version it calculates among its readout data the superelevation figure for the output unit while in its growth potential version it will also provide the elevation figure required for the sight head mirror movements and the drift and/or elevation control for the CRT generated sight graticule
- 4) a Singer Kearfort output drive unit which is provided only in the M48 and M60 MBT ATREOS systems
- 5) sensor package which in its basic form comprises crosswind and attitude measuring devices. Optional additions include an ambient air temperature and pressure measuring probe and a powder temperature sensor
 - 6) interconnecting cable set
 - gunner's control panel
 - 8) commander's control panel.

The gunner's basic sight system is interchangeable with existing M32 periscope units. The laser visual unit and the passive night vision elbow directly and respectively replace the M32 daylight and the M32 active infrared elbows to add day/night range finding and firing capabilities. The



ATREOS Fire-Control System Gunner's Sight System (+20° elevation version)

ballistic computer generates the traverse and elevation lead angles according to the selected ammunition type and the measured range. Its computation range is from 400 to 3500 m.

Status: Ready for production.

Manufacturer: Officine Galileo SpA, Via Einstein 35, I-50013 Campi Bisenzio, Florence, Italy

Telephone: (55) 89501 Telex: 570126 Fax: (55) 8950600

Galileo OG 14 L2B Tank Laser Fire-Control System

Development/Description

The OG 14 L2B modular fire-control system is designed for use in the OTO Melara OF-40 MBT which has so far been sold only to the United Arab Emirates, who purchased 36 vehicles in two batches of 18.

The system comprises the following components:

1) gunner's laser day sight, bi-ocular dual magnification \times 7 and \times 14

2) a GEC-Ferranti Defence Systems Type 520 Nd-YAG 1.06 μm wavelength laser rangefinder

3) a commander's VS 580-B 360° traverse gyro-stabilised day/night sight with a magnification of \times 8, stadiametric rangefinding capability and range scales for 105 mm APDS, HEAT and HESH ammunition

4) a digital ballistic computer

5) gunner's control panel

6) commander's control panel



Galileo OG 14 L2B fire-control system showing main components of system

- 7) loader's control panel
- 8) sensor package for such parameters as ambient meteorological conditions, powder temperature and lead angle measurements

9) interconnecting cable set.

With the complete sensor package fitted the ballistic computer can carry out lead angle computations with both the firing platform and target in motion while correcting for the meteorological conditions, powder temperature and gun wear.

The system's computer is also designed to accommodate a gun upgrade to 120 mm calibre. Optional dedicated software also allows on-vehicle crew training with the system.

SPECIFICATIONS

Dimensions

laser optical head	280 × 116 × 180 mm
gunner's laser control unit	280 × 170 × 75 mm
commander's laser control	
unit	218 × 131 × 91 mm
laser power supply unit	511 × 126 × 257 mm
OPERATING RANGE	400-10 000 m
ACCURACY	±5 m

VS 580-B sight

day channel	\times 3 and \times 10.5
night channel	\times 1.3 or \times 6

Ballistic computer

MAX COMPUTATION		
RANGE	4000 m	
MAX ELEVATION		
CORRECTION	±80°	
MAX TRAVERSE		
CORRECTION	±30°	

Status: Production as required (50 produced to date – 1 January 1993). In service with the United Arab Emirates.

Manufacturer: Officine Galileo SpA, Via Einstein 35, I-50013 Campi

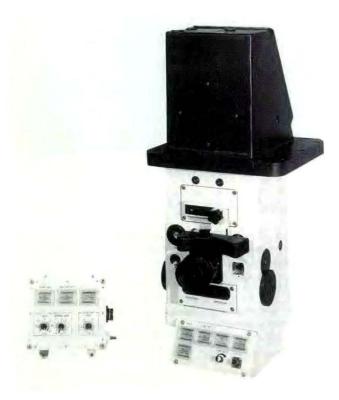
Bisenzio, Florence, Italy.

Telephone: (55) 89501 Telex: 570126 Fax: (55) 8950600

Galileo JANUS Fire-Control System

Development/Description

The JANUS dual purpose fire-control system is derived from the Officine Galileo P56 anti-aircraft model (which is used in a range of towed light anti-aircraft gun systems) and is designed for use on light armoured vehicles with turrets mounting 20-30 mm automatic cannon in both autonomous and netted anti-aircraft operational modes as well as for use against ground targets.



Galileo JANUS Fire-Control System Sight Assembly and Control Panel

The system comprises the following components:

- stabilised periscopic optical aiming sight assembly with fixed eyepiece, graticule illumination and dimming, control panel and dual axis servoed scanning mirror
- 2) 16-bit ballistic microcomputer with five main software sub-programs for kinematic, extrapolation, ballistic, lead angle and crossing range estimation tasks. The computer:
- a) calculates the future target position by processing the estimated target data, its tracking speeds and the stored ballistic information of the ammunition type selected
- b) then calculates the relevant lead angles for that position and, using the independent line-of-sight mode, transfers the information to the gun control system
 - c) controls the sights' independent scanning prism servos
 - d) provides all the interfaces to the turret
 - e) operates a control test facility
 - f) generates all the voltages required by the system to operate
- commander's control panel, which is used to control the computer and manually input the target information on type, speed and range
- 4) passive second or third generation night vision image intensifier unit which is inserted into the eyepiece of the aiming sight when required for night time engagements
- 5) gun elevation and traverse transducers which are used to sense the angular position of the gun and turret for the fire-control computer's calculations
 - interconnecting cable set.

The system's operating principles are indicated in the block diagram showing the inter-relationship between the independent sight's LOS and the gun's Line-Of-Fire (LOF).

In this way it is possible to continue viewing the target through the sight itself whilst the gun is actually orientated towards the calculated future target position.

The system's two firing modes are directed against the target types expected to be encountered. These are:

- a) the ground target engagement where the target has to be visually observed in the sight in order to produce an angular tracking speed and the fire-control parameters, entered manually into the computer. The relevant algorithm then calculates the gun lead angles
- b) the anti-aircraft engagement where the lead angles are calculated from the target speed only and manually introduced into the system. The target crossing range is automatically calculated by the fire control computer by processing the target speed and the relevant aiming angular velocity.

SPECIFICATIONS		IMAGE INTENSIFIER	
WEIGHTS		focal length	137 mm
optical sight assembly	33 kg	DISCOVERY RANGE	
computer unit	12.5 kg	2nd generation tube	2700 m
commander's control panel	1.5 kg	3rd generation tube	4000 m
SIGHT ASSEMBLY		TURRET	
traverse	±25°	servo speed	45-100°/s
elevation	-9° to +80°	acceleration	60-150°/s ²
magnification	× 5	power supply	24 V DC vehicle system
field-of-view	12°		

Status: Pre-production. Trialled on M113A1 APC fitted with two-man Belgian Cockerill turret and chosen by a number of other turret manufacturers.

Manufacturer: Officine Galileo SpA, Via Einstein 35, I-50013 Campi

Bisenzio, Florence, Italy.
Telephone: (55) 89501 Telex: 570126 Fax: (55) 8950600

JAPAN

Type 90 MBT Fire-Control System (FCS)

Development/Description

Mitsubishi Electric has developed a 'hunter-killer' type FCS for the Type 90 MBT. Both the vehicle's gunner and commander have full fire control facilities with the latter having an override authority.

The integrated FCS components include:

- a) a thermal sight system
- b) commander's independently stabilised panoramic sight
- c) gunner's dual sight head with a Nd-YAG laser rangefinder and independently stabilised day sight

d) digital ballistic computer which processes automatic sensor data like target range, vehicle cant angle, ambient air temperature and wind velocity with other inputs about parameters, such as ammunition data, to produce the firing solution.

Status: Production. In service with Japan on Type 90 MBT.

Manufacturer: Mitsubishi Electric Company, Mitsubishi Denki Bldg. 2 chome, 2-3 Marunouchi Chivoda-ku, Tokvo 100, Japan.

POLAND

SPECIFICATIONS

PEO Tank Fire-Control Systems

Development/Description

The PEO Tank Fire-Control System is designed for use with the T-series MBT. Two versions are available, the FCS Merida for the T-55 and the FCS Drawa for the T-72. Both are capable of providing a high probability of a first round hit on a stationary or moving target with the carrying platform stationary or moving and during daylight or night-time conditions. If required the FCS can be changed to suit other calibres of gun and different ammunition types by simply changing the computer software.

The basic system comprises:

- (a) the gunner's sight system with day and night channels for observation, target recognition and weapon aiming. On the T-72 the passive image intensifier night vision channel may be replaced by a thermal imaging unit. For modernised T-72 tanks the TPD-K1 sight replaces the existing PCD day sight.
- (b) integrated Nd-YAG laser rangefinder
- (c) ballistic computer which continually calculates the firing solution and, after taking into account all the relevant ammunition data and meteorological, dynamic and geometric sensor inputs, has an influence on the weapon aiming accuracy. A built-in self-test unit indicates the status of the system by operating individual satisfactory function lights for the laser rangefinder, computer and sensors
- (d) set of meteorological and dynamic/geometric sensors.

Most of the system units (except the sights) are interchangeable between the FCS versions.

FCS Type SIGHTS	Merida	Drawa
Day/night magnification	\times 3.5 and \times 7 day \times 7 night	n/app
field-of-view	14° and 7° day 7° night	n/app
PCD		
day magnification	n/app	\times 8 and \times 3
field-of-view	n/app	5° and 15°
PCN-A		
night magnification	n/app	× 5.4
field-of-view	n/app	5.6°
LASER RANGEFINDER TYPE	Nd-YAG	Nd-YAG
RANGING ACCURACY	±10 m	±5 m (PCD
sight) or ±10 m		
POWER SUPPLY	24-29 V DC	24-29 V DC

Status: Production as required. In service with the Polish Army and other undisclosed countries.

Manufacturer: PEO Warszawa, Industrial Centre of Optics, 75 Ostrobramaska St, PL-04-175 Warsaw, Poland Telephone (48-22) 13-74-98 Telex: 81 3877 PCO-PL Fax: (48-22) 13-94-24

SLOVENIA

Iskra EFSC-3 Tank Fire-Control System

Development/Description

The EFCS-3 fire-control system has been specially designed by Iskra for use with the T-55 and T-72 MBT. It is a full performance system with day/ night operations facilities, shoot-on-the-move capability and independent Line-Of-Sight (LOS).

The main components of the EFSC-3 are:

- (a) gunner's stabilised SGS-55 day/night laser sight
- (b) electronics box
- (c) gun elevation sensor
- (d) mechanical linkage unit for gun to SGS-55

- handwheel for turret manual drive
- fire-control computer
- commander's control panel (q)
- gunner's control block modification kit (h)
- (i) trunnion tilt sensor
- interconnection box
- (k) gun triggering electronics box
- interconnecting cable set.
- The data input to the ballistic computer includes:
- 1) either a manual target range reading or the target range from the laser rangefinder
- 2) data on one of up to six ammunition types and the coaxial machine gun

- 3) manually set secondary ballistic parameters (with optional automatic sensor input if fitted)
 - 4) deviation of nominal muzzle velocity
 - 5) ambient air temperature
 - 6) ambient air pressure
 - 7) ammunition powder temperature
 - 8) cross-wind speed
 - 9) automatically measured trunnion tilt
 - 10) automatically measured target azimuth angular velocity.

The computer then calculates the firing solution and outputs the azimuth (corrected for horizontal drift and cross-wind, parallax, gun jump and angular velocity) and elevation (corrected for vertical superelevation, parallax and jump) required to the weapon/turret control systems for the engagement.

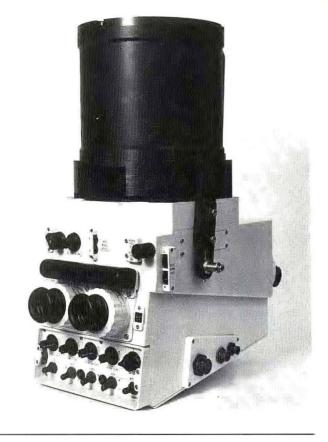
The computation of the ballistic data and parallax is done using an accurate ballistic model which is continuously updated following introduction of new parameters, such as different range reading or different ammunition selection. The tilt and lead angle correction calculations are repeated at the rate of 10 cycles per second.

Status: In production.

Manufacturer: Iskra Elektrooptiko Ljubljana DD, Stegne 7, PO Box 59,

61210 Ljubljana-Sentvid, Slovenia

Telephone: 386 1 571303 Telex: 3951851 iskceo



Iskra SGS-55 stabilised gunner's day/night laser sight for the EFCS-3 tank fire-control system

SOUTH AFRICA

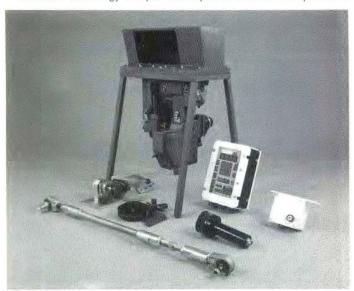
ESD High Integration Technology Tank Fire-Control System (HITT-FCS)

Development/Description

The ESD HITT-FCS has been designed to be a cost effective solution to the requirement for advanced fire-control systems in tanks and other armoured fighting vehicles.

The main components are:

a) Gunner's sight – this is a periscope assembly incorporating sight elbows for both day and night channels. Offset implementation is by means of motorised optical wedges. The day channel includes a Nd-YAG laser rangefinder with a maximum range of 9990 m and accuracy of ±5 m. An adjustable minimum range gate is provided along with multiple target indication and controls. Magnification of the day channel is × 8 with an 8° field-of-view. The night channel uses second generation image intensifier technology that provides a performance of 1.18 lp/mrad at



Main components of the ESD HITT fire-control system

- 10^{-1} lux for target contrast of 48 per cent. Magnification of the night channel is \times 7.1 with a 7.2° field-of-view. A back-up battery power supply provides emergency power if required for night operations. The night channel may be upgraded to a thermal infra-red version, accompanied by minor periscope modifications.
- b) Operator Panel this incorporates the ballistic processor and sight offset drive electronics. A numeric keypad and 2 × 24 line character LCD are used for calibration and testing requirements.
- The operational controls (including input facilities for six ammunition types) are located separately with LED type displays for ergonomic legibility. Keypad backlighting and annunciation is provided for ease of use. Drive electronics for the implementation of graticule offset in the thermal imager display are included.
- c) Meteorological and cant sensors Performance of these can be found in the following table:

Sensor Type

Meteorological (dual axis wind)

Performance

d) Mechanical linkages and back-up rangedrum – the mechanical linkage couples the sight periscope mirror and main armament together for synchronisation purposes while a back-up rangedrum is provided especially for indirect fire missions.

Status: Development complete. Ready for production.

Manufacturer: ESD (Pty) Ltd, 42 James Crescent, PO Box 35, Halfway House 1685, Republic of South Africa.

Telephone: (27) 11 315 555 Fax: (27) 11 805 3190

SPAIN

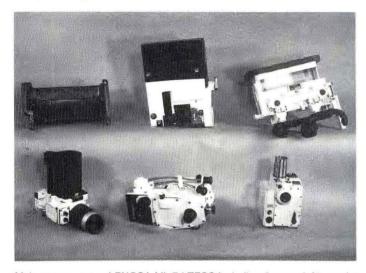
ENOSA Improved Mk 7 Laser Tank Fire-Control System (LTFCS) for M48A5E MBT

Development/Description

ENOSA is building under licence from Hughes Aircraft Company an Improved LTFCS for the locally upgraded M48A5E MBT. ENOSA also produces the LTFCS for the Spanish Army AMX-30E MBT.

The system has full solution day/night and shoot-on-the-move capabilities with automatic lead, using the following components:

- a) an M48A5/M60A3 digital solid-state ballistic computer to determine the gun aiming deflection and superelevation angles. The following inputs are made automatically from sensors:
 - i) target range
 - ii) cant angle



Main components of ENOSA Mk 7 LTFCS including (bottom left) passive night vision elbow and (bottom right) laser rangefinder unit

- iii) target angular velocity
- iv) cross-wind

while these parameters can be input manually:

- 1) range
- 2) ambient air temperature
- 3) altitude
- 4) cross-wind
- 5) gun jump correction
- 6) zeroing correction
- gun barrel wear.

Up to four ammunition type parameters are also stored.

- M32/M35 periscope assemblies
- c) automatic turret cant angle, turret tachometer (to measure target velocity for lead angle) and relative cross-wind velocity sensors
- d) modified M1 Abrams 1.064 µm Nd-YAG digital laser rangefinder unit with × 8 magnification and 7° field-of-view day telescope, ±10 m range and 30 m dual target resolution capabilities
- e) gunner's control unit with auxiliary manual input, boresighting, ammunition zeroing and self-test facilities
 - passive night sight with either:
- i) monocular image intensifier elbow with ×7 magnification and 7.3° field-of-view. Light gain is 1000 minimum with a focus range of 50 m to infinity. Resolution is 0.23 mil at 0.1 lux
- ii) monocular or binocular display 60-element HgCdTe linear array split, Sterling cooled, thermal imager unit, operating in the 7.5 to 11.8 μm wavelength spectral region. The wide field-of-view capability is 6.1° elevation and 12° azimuth. The narrow field is 1.7° elevation and 4° azimuth. Focus range is 75 m to infinity with NATO and laser cross graticules superimosed on the display
- g) gunner's and commander's ammunition selector units. Four basic ammunition selections can be made together with a stationary or moving selector option.

Status: Production as required. In service with the Spanish Army (on 164 M48A5E MBTs)

Manufacturer: Empresa Nacional de Optica SA (ENOSA), Poligono Industrial 'La Mina' (P.11), E-28770 Colmenar Viejo, Madrid, Spain. Telephone: (91) 846 01 00 Fax: (91) 846 01 02

SWEDEN

NobelTech Electronics AB Integrated Tank Fire-Control System Type FV

Development/Description

The first NobelTech (formerly Bofors Aerotronics) integrated fire control system with a stabilised Line-Of-Sight (LOS) was produced in 1972 for the Ikv-91 tank destroyer and was followed from 1982 onwards by a retrofit kit system with day/night capability, full stabilisation and upgraded gun servo system for a customer using T-series tanks. In 1983 the Swedish Army adopted a retrofit fire-control system kit for its upgraded Strv 101/102 Centurion MBTs using a stabilised aiming point and an improved gun servo system. In 1984 it adopted a retrofit Simrad Nd-YAG laser rangefinder for its Strv 103 S-tank fire-control system, and tested prototypes of a fire control computer which used the same software as the improved Centurion computer but with modified hardware.

A typical system comprises the following components:

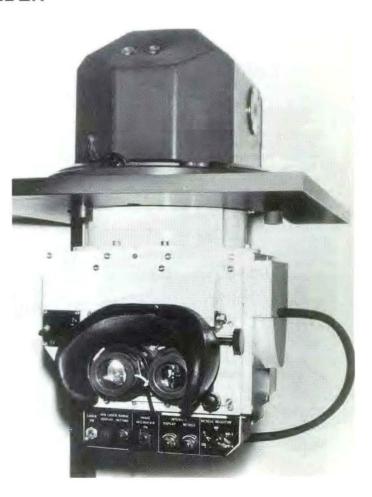
1) gunner's sight system with servo-controlled gyro-stabilised head mirror giving a LOS to the target which is independent of turret and hull movements. Its laser rangefinder and day and night vision channels are integrated and parallel so that the gunner can track targets and fire the laser without bringing the gun boresight onto the target.

The day channel has ×7 magnification with a 9° field-of-view and the passive night vision sub-unit uses a microchannel image intensifier tube with a \times 8.5 magnification and a 5.3° field-of-view

The integrated laser rangefinder is of the Nd-YAG type operating at the $1.06\,\mu m$ wavelength and has a maximum operating range of around 6000 m.

The sight servo system has the capability to control a second top mirror or to generate an aim-point for an infra-red vision sight

2) ballistic computer unit which calculates the correct gun laying angles using manual or automatic data inputs on target range, target angular velocity, ammunition type, trunnion tilt, parallax (gun bore to LOS), jump and drift, meteorological conditions (including crosswind information), powder temperature and barrel wear



T-series gunner's day/night sight for NobelTech integrated tank fire control system type FV

3) gunner control system which includes his control handle to control the LOS with its associated switch functions and a computer control panel on which to enter or read the computer data inputs

4) gun servo system which, by means of the hydraulic or electrical power drives, automatically directs the gun to the correct position for the calculated ballistics and lead angles

5) gyro box which has gyros for both gun stabilisation and automatic target rate measurements. A pendulum vertical reference system for automatic cant angle correction is also included.

The basic principle of operation is: the commander detects the target and presses his target acquisition button; the turret slews and the gunner's LOS is aligned with the commander's target direction; the gunner takes over the engagement and starts to track the target whilst firing a laser pulse; the target range is immediately displayed in the gunner's sight and fed to the computer; this takes the range data and all the other manual and automatic sensor parameters fed to it and continually calculates the superelevation and lead angles; these values are fed to the gun laying system which relays the gun in the correct position for firing without influencing the LOS or the possibility of further laser shots; the gunner then fires the gun; subsequent rounds are fired in quick succession as the lead angles are continuously being updated and the gunner can continue gun laying even during the loading procedure. The entire sequence is independent of whether or not the tank is on the move and takes around 12 seconds from target acquisition to the first shot.

Status: Production as required. In service with the Swedish Army (Centurion MBT) and several unspecified countries (T-series tanks).

Manufacturer: NobelTech Electronics AB, S-17588 Järfälla, Sweden. Telephone: +46 758 10000 Fax: +46 758 32277

SPI	ECIF	ICA	TIONS	(typical)	
-	(6)	-			

Gun sight

NIGHT MAGNIFICATION $\times 8.5$ DAY MAGNIFICATION FIELD-OF-VIEW NIGHT FIELD-OF-VIEW DAY 9

5.3°

Computer

RANGE **AMMUNITION TYPES** MAX SUPERELEVATION AND NEGATIVE LEAD ANGLE IN **ELEVATION** LEAD ANGLE MAX LEAD ANGLE AND WIND

MUZZLE VELOCITY, NOMINAL

CORRECTION

JUMP MAX

200 to 6000 m (laser and manual)

+70 mrad to -10 mrad ±40 mrad

±45 mrad +5 mrad +50 m/s

AIR TEMPERATURE -30° to +50°C AIR PRESSURE, NOMINAL +100 to -300 mm Ha CROSSWIND +20 m/s POWDER TEMPERATURE -30° to +50°C MAX TRUNNION TILT ±14°

Control system

MAX AZIMUTH SPEED MAX AZIMUTH SPEED OF TARGET

MAX ELEVATION SPEED MAX ELEVATION SPEED

OF TARGET LASER RANGEFINDER TYPE **PULSE POWER** PULSE DURATION TIME BETWEEN MEASUREMENTS

MAX RANGE (typical)

±300 mrad/s

±80 mrad/s ±80 mrad/s

±20 mrad/s Nd-YAG 1.8 MW 15-20 ns 15

6000 m

NobelTech Universal Tank and Anti-Aircraft System - UTAAS

Development/Description

The UTAAS fire-control system has been developed by NobelTech (formerly Bofors Aerotronics) for use with both new build and retrofitted AFVs and air defence guns. Its first application is the Combat Vehicle 90 series of armoured vehicles developed to meet the requirements of the Swedish

UTAAS is a sight and fire-control system with modular structure available in a variety of configurations which depend upon the customers requirements for the sophistication level.

UTAAS with an Advanced Tank Fire-Control Computer

This is an advanced fire-control system to combat moving ground targets and helicopters. The UTAAS, with laser rangefinder and fire control computer, is supplemented by a cant angle sensor and interface to the gun laying system to provide an independent line-of-sight.

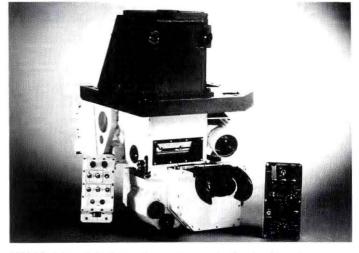
The system is specifically designed to shorten the reaction time and achieve a high hit probability against moving targets when firing from a moving vehicle. The aiming operations of the gunner are made easier by the fact that the system generates an independent, secondary stabilised line-of-sight. The gunner needs only to track the target in the reticle centre and fire the laser. The fire-control system then calculates the firing solution and guides the barrel to the calculated superelevation and lead angle whilst the line-of-sight remains on the target.

The superelevation and lead angle are calculated as a function of the:

- (a) target range
- (b) target speed
- (c) ammunition type
- (d) muzzle velocity deviation and charge temperature
- (e) gun jump
- (f) air temperature
- (g) air pressure (h) wind velocity
- (i) trunnion tilt.

Status: Production for CV 90 40 of Swedish Army.

The UTAAS air defence gun version has been evaluated on modernised towed AA guns such as a Chinese twin 37 mm model and the 40 mm Bofors L/60 (for more details see Towed Anti-Aircraft Gun Sights section in the current edition of Jane's Land-Based Air Defence)



UTAAS sight with Kollsman thermal imager for Combat Vehicle 90

SPECIFICATIONS

ELEVATION LIMITS -10° to +35° TRAVERSE ±159 FIELD-OF-VIEW azimuth 35° elevation 15° DAY CHANNEL magnification × 8 field-of-view 8 >40% transmission LASER RANGEFINDER wavelength 1.064 µm extinction ratio >32 dB ground target >42 dB air target pulse repetition frequency

1 Hz for 3 s, 12 pulses/min ground target air target 4 Hz for 10 s, 1.5 Hz continuously

Manufacturer: NobelTech Electronics AB, S-17588 Järfälla, Sweden. Telephone: +46 758 10000 Fax: +46 758 32244

TAIWAN

M48H Advanced Fire-Control System

Development/Description

The Taiwanese Chung Shan Institute of Science and Technology has developed an advanced fire-control system for the M48H hybrid MBT. This uses new M60A3 tank hulls purchased from General Dynamics Land Systems Division before the production line closed down, modified M48A5 type turrets and a locally produced United Services Ordnance Institute of Taiwan version of the 105 mm M68 rifled tank gun.

The fire-control system incorporates a CO2 laser rangefinder (supplied by Texas Instruments), a ballistic computer and a thermal imaging sight.

Status: In production. In service on M48H MBTs in service in Taiwan.

Manufacturer: Chung Shan Institute of Science and Technology, Taiwan.

UNITED KINGDOM

Barr and Stroud Computerised Thermal and Optical Fire-Control Equipment

Development/Description

Barr and Stroud offer a computerised thermal and optical fire-control system for retrofitting of existing tanks or incorporating into a tank at the design stage. The equipment is designed so that no major penetration of the main armour and only minimum modification to other systems is needed.

The subsystems which comprise this equipment include:

- (a) Visual Sight wherever possible it is preferred to combine the existing optical sight into the fire-control system
- (b) Barr and Stroud LF19 laser rangefinder a stand alone rangefinder system with separate head and electronics units. Other options could be the existing laser rangefinder fitted or one incorporated into the
- (c) Barr and Stroud Thermal Imaging Sensor Head (TISH) containing the afocal telescope and a scanner assembly. The telescope provides a wide angle field-of-view for general surveillance and target detection and a narrow angle field-of-view for target recognition and engagement. Operating waveband is 8-11.75 µm
- (d) Coolant Supply System a cryogenic high pressure air system to cool the Sprite detector of the TISH scanner assembly. Alternatives can be
- (e) Telescope Injection Unit (TIJ) which injects the computer driven aiming mark into the optical sight. It can be used with either telescopes or periscopes
- Sight Display Drive Unit (SDDU) this acts as the supply filter for the TIU and itself. It also functions as the drive to the TIU to position the aiming mark correctly in the optical sight
- (g) Turret Displacement Unit (TDU) this is used in conjunction with the laser switch to determine the fire solution lead angle for crossing targets. A Gun Elevation Displacement Unit (GEDU) may also be fitted to improve this facility

- (h) Trunnion Tilt Sensor which transmits any trunnion tilt (cant) angle to the EPU for inclusion in the ballistic computer processing
- Electronic Processing Unit (EPU) The EPU provides the necessary filtering and conversion of the vehicle's 28 V nominal electrical power supply to the thermal system and to itself. It also completes the conversion of the thermal signals to standard TV compatible CCIR 625 line 50 Hz signals (an alternative 525 line 60 Hz CCIR system is available). In addition, it generates the text and aiming marks and adds them to the CCIR signals passed to the Crew Display Units. The aiming mark data is processed from the inputs from the laser rangefinder, trunnion tilt sensor and turret displacement unit to position them in the thermal field-
- Control Unit this contains all the functions necessary for target engagement and operation of the system. The thermal controls include focus, gain, black level and polarity (that is, white is hot or black is hot). The unit may be located at the commander's or gunner's station, or both
- Commander's Display Unit (CDU) and Gunner's Display Unit (GDU) the thermal image picture is displayed on these biocular display units, together with the aiming marks and Built-In Test Equipment (BITE) messages. Both units show the same scene, marks and message text. A facility is provided whereby the displays may only be activated when the operator's face is pressed against the brow pad so as to prevent any stray light escaping through the normal optics during night operations.

Status: Production as required.

Manufacturer: Barr & Stroud Limited, 1 Linthouse Road, Glasgow, G51 4BZ, Scotland.

Telephone: (041) 440 4000 Telex: 778114 GLW G Fax: (041) 440 4001

Marconi Centaur Tank Weapon Control System

Development/Description

The Centaur system is a combined modular weapon and fire-control system that has been developed as a private venture by Marconi Radar and Control Systems and is being offered in two formats.

For the new build Vickers Mk 7 and ENGESA Osorio MBTs with stabilised sights the following system configuration has been chosen:

PROCESSING

electronics cubicle

aiming mark graphics unit

CONTROL

control panel

thumb/duplex controllers

safety/interlock switches

POWER

solid state power amplifier power amplifier switch unit traverse/elevation servos

SENSORS

hull/breech gyros vertical reference unit meteorological package traverse/elevation rate

compatibility

stabilised panoramic fixed with CRT thermal imager image intensification laser rangefinder

performance

360° slew in nine seconds 90° target switch in four seconds slow speed tracking at less than 0.2 mil/s FCS computation accuracy 0.1 mil

additional features

automatic drift compensation gunner's thermal display fired rounds data display full system built-in test equipment extended range capability mean point of impact adjust facility.

For the T-55 and Type 59 MBTs and the Vickers/FMC VFM Mk 5 battle tank fitted with standard fixed sights the following configuration is used: **PROCESSING**

electronics cubicle

aiming mark graphics unit

CONTROL

control panel thumb/duplex switches

safety/interlock switches

solid state power amplifier power amplifier switch unit traverse/elevation servos

SENSORS

breech gyros meteorological package traverse/elevation rate

SIGHTS

compatibility

fixed sights with CRT thermal imager image intensification laser rangefinder

performance

360° slew in typically nine to twelve seconds 90° target switch in four seconds slow speed tracking at less than 0.2 mil/s FCS computation accuracy 0.1 mil

additional features

automatic drift correction gunner's thermal display fired rounds data display full system built-in test equipment extended range capability mean point of impact adjust facility

Both configurations allow the engagement of static and moving targets while the firing platform is stationary or moving.

Status: Development complete. Trialled on Vickers Mk 7 MBT, Vickers/FMC VFM Mk 5 battle tank and ENGESA EE-T1 Osorio MBT. Ready for production. In 1991 Centaur was installed in a Chieftain MBT for trials purposes.

Manufacturer: Marconi Radar and Control Systems Limited, New Parks,

Leicester LE3 1UF, UK.

Telephone: (0533) 871481 Telex: 34551 Fax: (0533) 871746

Typical system components for Centaur Weapon Control System: (top) control panel (bottom left) processing unit, (bottom right) solid state power amplifier







Marconi Digital Fire-Control System

Development/Description

The Marconi Digital Fire-Control System (DFCS) has been designed as a private venture, to be both a new-build fit and a retrofit kit for upgrading light and medium armoured fighting vehicles with sophisticated fire control system technology.

Based on experience gained with the improved Fire Control System, the modular and compact components of the DFCS can be fitted into the restricted space turrets of light armoured vehicles such as the Cadillac Gage Textron V-150 and V-600 and tanks such as the Cadillac Gage Textron Stingray, M41, M48, T-54/T-55 and Chinese Type 59 family.

It has been trialled on the V-150 (4 \times 4) and V-600 (6 \times 6) vehicles and the Cadillac Gage Textron Stingray light tank armed with a 105 mm gun, the latter being the first production application.

Facilities offered with the system include moving target engagement capability, automatic gun laying and a built-in gunnery training simulator. It also has fire-on-the-move capability for MBT applications. Its performance is compatible with the accuracy of 76, 90, 105 and 120 mm calibre guns, even at extended ranges using low velocity HEAT and HESH ammunition.

The main elements of the system are as follows:

 1) 16-bit digital computer with power supply unit that runs off the vehicle's own supply. The computer incorporates self-test software and permanently retains information such as barrel wear data and shoot-in adjustment details, apart from performing the firing solution calculations

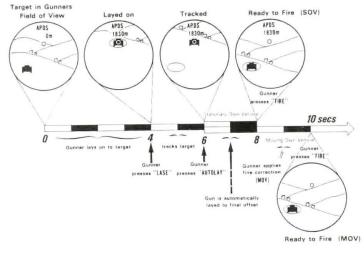
- commander's control panel which interfaces to the computer and provides the following facilities:
 - a) system and calibration confidence checks
 - b) designation and display of ammunition type
- c) entry of ballistic data such as charge temperature, air density, barrel wear and individual gun characteristic correction
 - d) monitor of sensor inputs
 - e) manual data entry in the event of a sensor failure
 - f) entry of add/drop corrections
- 3) CRT driver unit, which provides the computer controlled display images in the gunner's and commander's sights including the aiming mark, alphanumeric range and ammunition type selected. It also provides a simulated target shape and tracer trajectories in the training mode
- 4) ballistic sensor package, which normally has measuring equipment fitted for trunnion tilt information and meteorological data such as crosswind velocity and direction, together with optical encoders for traverse and elevation, in order to provide high quality target tracking and to ensure accurate automatic gun laying
- 5) a rigidly mounted hand controller unit for gun laying, laser ranging and firing that also allows for demands in elevation and traverse.

For an electrical turret servo the firing handle and thumb controller provide the gunner with all the controls necessary to conduct an engagement, ie weapon selection, ammunition designation, lasing, autolaying and firing.

Similar controls are provided on the duplex controllers when a hydraulic turret servo is preferred.



Main components of Marconi Digital Fire-Control System



Typical Marconi Digital Fire-Control System target engagement

In a typical engagement against enemy armour the AFV firing platform would normally have its main gun pre-loaded with an armour defeating ammunition type such as HEAT and be in the ready-to-fire state. The commander would select the target and slew the turret around to its azimuth while giving the fire order to the gunner. The gunner confirms when he sights the target, selecting with his hand controller the main gun and ammunition type loaded.

The HEAT text is then displayed in his sight eyepiece and he uses the power servo hand controller to lay onto the target, presses the laser ranging switch and continues to track the target.

The laser range target value in now displayed in the gunner's sight and the computer displays the DFCS aiming mark which is scaled to the target at its measured range and is centred on the aiming mark. The computer than processes the meteorological and trunnion tilt sensor data in order to calculate the ballistic aim-off value.

The gunner, having tracked the target for approximately two seconds, presses the autolay switch. The computer adds the average target motion correction to the ballistic aim-off value and generates a corrected aiming point in the sight. Within the next two seconds the computer automatically commands the gun and turret servos to move the barrel to this corrected position.

At the coincidence of the aiming mark and the target the gunner fires the main gun by depressing the firing switch. The total time from the commander selecting the target to the gun firing is typically eight seconds.

Status: Production as required. In service with Stingray light tanks (106) used by Thailand.

Manufacturer: Marconi Command and Control Systems Limited, New Parks, Leicester LE3 1UF, UK

Telephone: (0533) 871481 Telex: 34551 Fax: (0533) 871746

Other Fire-Control Equipment from Marconi

In addition to the Marconi Centaur Tank Weapon Control System and the Digital Fire-Control System described in the two previous entries, Marconi Command and Control Systems has developed a complete range of fire-control systems for applications in a wide variety of AFVs.

These include the Marconi Simplified Fire-Control System (SFCS 600) and the Marconi Enhanced Fire-Control Systems (EFCS 600) (Jane's Armoured Fighting Vehicle Systems 1988-89 page 370) which have been trialled in such vehicles as the M48, Vickers Mk 3, Vickers Mk 3 (I), Centurion, Chieftain, Challenger 1 and T-54/T-55/Type 59. EFCS 600 is standard fit on the Vickers Mk 3 MBTs of the Nigerian Army.

Two further systems are already in service with the British Army. These are the Marconi Improved Fire Control System (IFCS) (Jane's Armoured Fighting Vehicle Systems 1988-89 page 371), which is standard fit on the Chieftain, and the Marconi Improved Computer Sighting System (ICSS) (Jane's Armoured Fighting Vehicle Systems 1988-89 page 371), which is a standard fit on the Challenger 1 MBT.

Manufacturer: Marconi Radar and Control Systems Limited, New Parks, Leicester, LE3 1UF, UK.

Telephone: (0533) 871481 Telex: 34551 Fax: (0533) 871746

UNITED STATES OF AMERICA

Alliant Techsystems Automatic Fire-Control System (AFCS)

Development/Description

Alliant Techsystems Ordnance Systems is in limited production of the M109A6 Paladin howitzer AFCS. Over 200 systems have been ordered in the FY89/90 and FY91/92 appropriations. The programme is managed by PM-Paladin under direction of PED-Armaments.

The AFCS is designed to allow rapid emplacement of the M109A6, swift gun order communication, automated weapon laying, and rapid switching of the gun tube from target to target.

The main subsystems are:

- a) Display/Control Unit (DCU) with a menu-driven flat panel electroluminescent display with alphanumeric and graphic capabilities. The DCU has system interfaces to external computers or Command Control Communications (C³) networks
- b) Ballistic Computer/Weapon Controller (BC/WC) which provides automatic gun laying facilities and reduces the howitzer's response time and radio net traffic needs

- c) Power Conditioning Unit (PCU) which provides a 'smoothed' power supply to the AFCS and contains sealed self-contained back-up batteries
- d) a Modular Azimuth Positioning System (MAPS) Dynamic Reference Unit (DRU) for land navigation needs
- e) Communications Processing Unit (CPU) which provides an interface between the external radio net and the howitzer's fire-control system via a dual redundant 1553B databus. It also has encryption capability and interfaces to external BCS, TACFIRE, AFATDS, DMD, FIST DMD, Firefinder, ATHS and RPV artillery fire support systems.

Status: Contracted for limited initial production. Fitted to US Army M109A6 self-propelled howitzer.

Manufacturer: Alliant Techsystems Inc, 5901 Lincoln Drive, Edina, Minnesota 55436, USA.

Telephone: (612) 939 2445 Fax: (612) 939 2749

Texas Instruments Extended Range Gunnery Fire-Control Demonstration System (ERGFCDS)

Development/Description

In January 1991 the Defense Systems & Electronics Group of Texas Instruments was awarded an \$18 million contract by the US Army's Armament, Munition and Chemical Command (AMCCOM) to demonstrate advanced fire-control concepts and techniques for the Armored Systems Modernisation programme.

The 39-month contract for the ERGFCDS will result in the development of a fire-control system that is applicable to the family of combat vehicles.

The ERGFCDS is a four-phase technology demonstration programme which is to culminate in the demonstration of the advanced fire-control technology applications on the Tank Component Advanced Technology Test Bed.

Texas Instruments will implement the fire-control system based on the

Standard Army Vectronics Architecture (SAVA) and demonstrate automatic target detection, cueing and tracking, digital adaptive stabilisation, sensor data fusion, electronic gun/turret drives and embedded training.

To assist in the ERGFCDS effort Texas Instruments has assembled a broad base of subcontractors including DY-4, MOOG, Martin Marietta and Bockwell

Status: Technology demonstration phase.

Manufacturer: Texas Instruments Incorporated, Electronic Systems Division, Business Development Manager, 2501 W University, MS 8046, McKinney, Texas 75070, USA.

Telephone: (214) 952 2000 Cable: TEXINS

Texas Instruments Modular Target Acquisition System (MTAS)

Development/Description

Texas Instruments is developing a new concept of fire-control system known as the Modular Target Acquisition System (MTAS) which will have the ability to find, identify and automatically track and engage multiple targets simultaneously and at extended ranges.

It will be applicable to the following system types:

- (a) Anti-Armor Weapons Systems-Heavy (AAWS-H), eg the Kinetic Energy Missile (KEM), Advanced Missile System-Heavy (AMS-H) and the current and future TOW upgrades
- (b) Air Defence Systems
- (c) Armored Family of Vehicles
- (d) Armour Projectile Systems.

It is reconfigurable for many weapon systems and expandable to incorporate Preprogrammed Product Improvement (P³I). The system will also perform management of ordnance and other weapon system stores.

The MTAS hardware features a standardised control station, common vehicle databus and next generation focal plane thermal imaging system. Other characteristics include a continuously running Built-In Test (BIT), fault isolation to the module level, automatic boresight control and an embedded training facility which allows crew members to acquire individual position skills as well as training as a part of a weapons team.

Status: Development.

Manufacturer: Texas Instruments Incorporated, Electronic Systems Division, Business Development Manager, 2501 W University, MS 8046, McKinney, Texas 75070, USA.

Telephone: (214) 952 2000 Cable: TEXINS

Texas Instruments Full-Solution Tank Fire-Control System

Development/Description

The Full-Solution Tank Fire-Control System provides state-of-the-art technology for later M-series and similar type MBTs to enhance their target acquisition, hit probability and shoot-on-the-move capabilities.

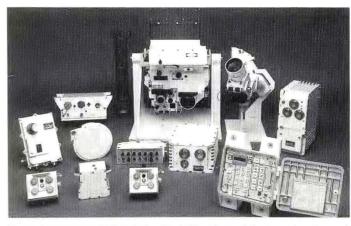
The system consists of the following sub-units:

- (a) Texas Instruments AN/VSG-2 Tank Thermal Sight (TTS) with integrated Nd-YAG laser rangefinder. The latter has a range display in the gunner's and commander's thermal displays, automatic ballistic solution entry, continuous one pps duty cycle, first/last pulse logic and a single reticle for laser boresighting and gun solution
- (b) commander's extension for TTS
- (c) computer electronic unit with the computer having the capability to determine full ballistic solutions for all standard NATO and US round types from data input from the laser rangefinder and other sensors. It can also be easily re-programmed in the field for new round types
- (d) computer control panel
- (e) electronic interface unit
- (f) gunner's ammunition type selection panel
- (g) gunner's control panel
- (h) output unit
- (i) commander's ammunition type selection panel
- (j) power supply
- (k) sensor package including rate/tach, cant and wind measuring units.

Status: Production as required.

Manufacturer: Texas Instruments Incorporated, Electronic Systems Division, Business Development Manager, 2501 W University, MS 8046, McKinney, Texas 75070, USA.

Telephone: (214) 952 2000 Cable: TEXINS



Texas Instruments Full-Solution Tank Fire-Control System showing main components

Texas Instruments Improved M60A3 Fire-Control System

Development/Description

The improved M60A3 Fire-Control System has been designed as a private venture by Texas Instruments as a retrofit package to upgrade the current fire-control system of the M60A3 MBT. The main subsystem changes are:

- replacement of the M21 ballistic computer unit with a programmable M1 digital computer and electronic interface unit to improve the firing accuracy, allow for automatic target tracking and provide the gunner with automatic ballistic data inputs
- 2) replacement of the current ruby laser rangefinder in the Tank Thermal Sight (TTS) unit with an eye-safe CO^2 laser rangefinder that is much smaller and more compact. The laser requires only one periscope, no parallax correction and has an operational wavelength of 10.59 μ m with a measurement range of 400 to 10 000 m. The target range measurement accuracy is ± 5 m and the target resolution 5 m, with the range output in digital format. The weight of the laser rangefinder unit is only 9.09 kg.

The laser rangefinder it replaces requires two periscopes, parallax correction and a safety filter fitted to the periscope unit because its direct or reflected energy can cause blindness. The operational wavelength is 0.694 μm with a measurement range of 200 to 5000 m. The target range measurement accuracy is ± 10 m and target resolution 20 m with the range output in analogue format. Total weight of the laser rangefinder system is 76.36 kg

 optional fitting of a thermal imaging charge couple device camera for automatic tracking, remote viewing, sight video recording and training purposes.

Status: Ready for production.

Manufacturer: Texas Instruments Incorporated, Electronic Systems Division, Business Development Manager, 2501 W University, MS 8046, McKinney, Texas 75070, USA.

Telephone: (214) 952 2000 Cable: TEXINS

Texas Instruments Thermal Imaging Multisensor System

Development/Description

The Texas Instruments Thermal Imaging Multisensor System (TIMS) stabilised sight unit can be packaged for use as a surveillance and fire-control system on armoured vehicle turrets.

The system provides passive day or night automatic tracking and fire-control solutions for a variety of applications such as air defence, surveillance and target ranging and tracking.

The subsystems comprise the following units:

- 1) fully stabilised sensor unit, which integrates a thermal imaging forward looking infra-red system with a high resolution day charge-couple device TV unit, providing similar $2.3\times3.1^\circ$ narrow and $6.9\times9.2^\circ$ wide fields-of-view, a CO $_2$ laser rangefinder with a 10 000 m range capability and an automatic tracker. The stabilisation is in two axes with the sensor's azimuth range being a full 360° and its elevation range from –20 to +75°
- 2) control/display console for the operator
- 3) sight control/auto tracker unit with integral digital microprocessor
- 4) laser rangefinder electronics unit
- 5) servo electronics unit to provide power and stabilisation control to the
 - 6) power supply unit to provide an interface to the vehicle supply
 - 7) interconnecting cable set.

Status: Ready for production.

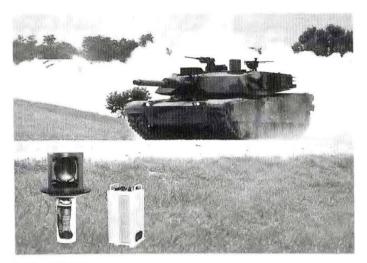
Manufacturer: Texas Instruments Incorporated, Electronic Systems Division, Business Development Manager, 2501 W University, MS 8046, McKinney, Texas 75070, USA.

Telephone: (214) 952 2000 Cable: TEXINS

Rockwell Multi-Sensor Target Acquisition System

Development/Description

The Multi-sensor Target Acquisition System (MTAS) is a multi-sensor detection, tracking, recognition and target engagement system that greatly improves the fighting capability and effectiveness of armoured vehicles such as the M1 Abrams MBT. MTAS combines the complementary capabilities of the onboard FLIR sensor, daysight, and laser rangefinder with an added low probability of intercept, millimetre wave, radar sensor.



Rockwell Multi-Sensor Target Acquisition System on M1A2 with components of system below

MTAS has its origin in several US Government and Rockwell International Corporation-funded programmes. The US Army Integrated Surveillance Target Acquisition Radar for Tank Location and Engagement (ISTARTLE) programme demonstrated that a radar-controlled gun mounted on an armoured vehicle could perform rapid firing with direct-hit accuracy. The Rockwell Instrumented Millimetre Wave System (RIMS) and Assessment of Stationary Target Acquisition Technique (ASTAT) programmes have taken simultaneous millimetre wave (MMW) and IR measurements on stationary targets for analysis and development of detection, recognition, and fusion algorithms. Additional studies and analyses have shown significant benefit for tanks, helicopters and elevated sensors.

MTAS consists of an MMW radar antenna assembly mounted on top of the tank turret while the radar electronics, high speed digital processor unit and display are mounted inside the turret. The antenna is designed for minimal exposure above the turret line while exposed portions of the antenna are protected by an armoured shield. Radar target data are presented on a tank commander's display, the gunner's TIS display, and sent to the fire-control system. The main gun may be accurately and rapidly fired using only MTAS radar data or combinations of radar, FLIR, and visual data. MTAS radar will not increase tank vulnerability because the radar transmissions and processing are designed to ensure low probability of intercept and countermeasure resistance.

The aim of MTAS is to provide all-visibility panoramic surveillance and search capabilities with automatic target detection and discrimination during typical battlefield obscuration and adverse weather conditions.

Status: Field trials.

Manufacturer: Rockwell International Corporation, Tactical Systems Division, Defense Electronics Operations, 3370 Miraloma Avenue, PO Box 3105, Anaheim, California 92803, USA.

Telephone: (714) 762-6491 Fax: (714) 762-3590

YUGOSLAVIA (Serbia/Montenegro)

SUV-84 Tank Fire-Control System

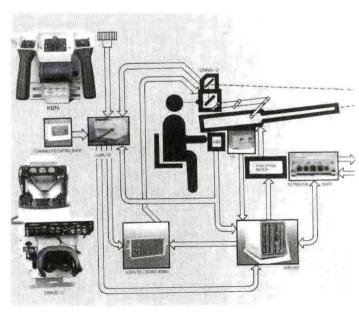
Development

The SUV-84 is an indigenous developed fire-control system for the T-72 MBT model (produced locally under the designation 'Tenk M-84'). Fitting of the SUV-84 has resulted in the deletion of the TPD-2-49 laser rangefinder port on the front left side of the turret and the replacement of both the gunner's TPN-1-49-23 periscopic sight/stadiametric rangefinder unit and the commander's TKN-3 day/night sight.

Description

The SUV-84 is a full solution fire-control system with target acquisition and tracking capabilities in both day and night conditions with independent line-of-sight equipment.

The gunner has a DNNS-2 monocular day/night sight assembly with integrated laser rangefinder. The night vision channel uses a passive image intensifier elbow.



Block diagram of SUV-84 fire control system for M-84

For an engagement the ballistic computer is automatically fed acquired data on the target's range, turret turn rate, tank tilt angle, ambient air temperature and pressure and cross-wind from the various sensor units. The superelevation and deflection angles are then calculated and transmitted to the two-axis automatic electrohydraulic system of the 125 mm smoothbore D-81TM (2A46) main gun and coaxial 7.62 mm machine gun for aiming purposes.

The fire-control system has three modes of operation: the fully automated stabilised mode described above; a semi-stabilised mode; or a back-up mechanical (that is, manual) one, using hand traversing and visual aiming techniques.

Engagement cycle time can vary between 0.5 to 2 minutes depending upon the target type and meteorological conditions.

The tank commander has a binocular DKNS-2 day/night periscope sight with an image intensifier passive night vision elbow. Magnification of the day channel is \times 4.9 with a 10 $^\circ$ field-of-view while the night vision channel magnification is \times 4.3 with a 10.9 $^\circ$ field-of-view.

SPECIFICATIONS

Gunner's DNNS-2 Sight

7.62 mm machine gun

MAGNIFICATION	
day channels	\times 7 and \times 3
night channel	× 8.5
FIELD-OF-VIEW	
day channels	9° and 20°
night channel	5.3°
LASER OPERATING RANGE	200-9995 m
Computer	
MUZZLE VELOCITY VARIANCE	±50 m/s
CROSS-WIND LIMITS	±25 m/s
MAX CANT ANGLE LIMIT	15°
AMMUNITION TYPE	
COMPUTATION RANGES	
HEAT-FS	200 - 4000 m
HVAPFSDS	200 - 4000 m
HE-FS	200 - 6000 m

Status: Production as required. In service with the Kuwaiti and Yugoslav Armies (on M-84 series MBT).

200 - 1500 m

Manufacturer: Enquiries to contractor: SDPR – Federal Directorate of Supply and Procurement, PO Box 308, 9 Nemanjina Street, 11105 Belgrade, Yugoslavia (Serbia/Montenegro).

Telephone: (11) 621 522 Telex: 11360/11541 YU SDPR

Cable: DIRPROM Fax: (11) 635 702

Anti-tank Gun Fire-Control System

Development/Description

The anti-tank gun FCS is designed for use on various types of anti-armour guns including recoilless rifles. It enables the observation, target distance measurement, target tracking and firing at both static and moving targets during day or night engagements.

The FCS comprises the following subsystems:

- (a) day/night sight with integral 1.064 μm wavelength Nd-YAG laser rangefinder unit
- (b) built-in solid-state ballistic Digital Computer (DC) which controls the whole system (including the laser firing) and calculates the firing solution lead angle and superelevation figures using laser range data, manually input meteorological and ammunition data (up to four types of information stored). Once the solution is calculated it then generates an electronic aiming mark within the sights field-of-view.
- (c) exchangeable Battery Block (BB)
- (d) angle speed sensor (for direction and elevation)
- (e) interconnecting cable set

All the gunner has to do during an engagement is acquire the target, fire the laser, lay the weapon to the calculated firing parameters and fire the weapon.

Up to the maximum target distance, which is a function of the weapon type and the ammunition type used (for example, for a 106 mm recoilless rifle it would typically be 1000 m), the required superelevation is directly indicated by an aiming mark, offset in the vertical direction so that there is

no necessity to display the range and possibly distract the gunner. However, if required, the gunner can press a button and recall the value for display on a four digit seven segment LED display which superimposes itself onto the image he is viewing through the system eyepiece.

For ranges above the engagement limit it is assumed that only soft targets are being engaged which have a negligible crossing speed so that in most instances it is not necessary to calculate a lead angle. To allow the gunner to fire the weapon with a minimum of delay the range display appears in the gunner's field-of-view immediately after the LRF is activated. All he has to do then is lay the weapon in elevation by use of the built-in ballistic reticle. If the lead angle is required then it is still possible to observe the target movement during the TOF indicated by the BBC. The reticle has horizontal lines corresponding to ranges of 200 to 2000 m and vertical lines for lead angle determination.

Status: Production as required. In service with the Yugoslav Army.

Manufacturer: Enquiries to contractor: SDPR – Federal Directorate of Supply and Procurement, PO Box 308, 9 Nemanjina Street, 11105 Belgrade, Yugoslavia (Serbia/Montenegro).

Telephone: (11) 621 522 Telex: 11360/11541 YU SDPR

Cable: DIRPROM Fax: (11) 635 702

SPECIFICATIONS

 WEIGHT
 approx 40 kg

 DIMENSIONS
 550 × 280 × approx 260 mm

TARGET SPEED TRACKING RATES

traverse 0-20 mrad/s
elevation 0-10 mrad/s
resolution 0.001 mrad/s
POWER SUPPLY 12 V exchangeable battery block

Day sight

MAGNIFICATION × 6.5 FIELD-OF-VIEW 7°

Night sight

MAGNIFICATION × 7.7
FIELD-OF-VIEW 6.5°
OBSERVATION DISTANCE >900 m

(at $1 \times 10^{-3} lux$)

Laser Rangefinder

TYPE
WAVELENGTH
AUTOMATIC LASER MEASURING
DISTANCE
AUTOMATIC LASER MEASURING
DISTANCE ACCURACY

MANUAL LASER MEASURING DISTANCE

MANUAL LASER MEASURING DISTANCE ACCURACY RESOLUTION

MINIMUM RANGE GATING

Nd-YAG 1.064 μm

180-10 000 m

±10 m

100-9995 m

±1 m 5 m 200-3400 m

Rudi Čajavec SUV-T55A Tank Fire-Control System

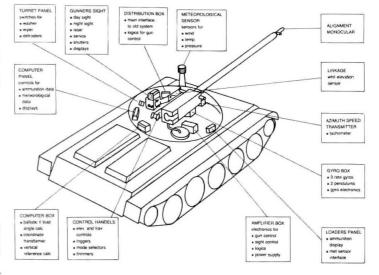
Development/Description

The tank Fire-Control System (FCS) type SUV-T55A is designed for use on T-55 and T-62 MBTs, as well as for retrofitting to modified T-55 (with 105 mm main guns) and Chinese Type 59 MBTs. The system ensures a high first round hit probability at long ranges during day and night conditions against both static and moving targets whilst the platform vehicle is stationary, and against both stationary and moving targets in the day time whilst it is moving. Typical engagement conditions for these scenarios are:

PlatformTargetstationarystationary (size 2.3×2.3 m)stationarymoving (size 4.6×2.3 m, speed 40 km/h)moving (speed 25 km/h)stationary (size 4.6×2.3 m)moving (speed 25 km/h)moving (size 4.6×2.3 m, speed 40 km/h)

The modular SUV-T55A system comprises the following subsystems:

- (a) day/night gunner's stabilised sight with independent line-of-sight target observation, integrated Nd-YAG 1.064 μm laser rangefinder and second generation passive night vision image intensifier tube assembly (optional thermal imager capability)
- (b) manual input computer panel (which displays target range and other system data)
- (c) combined meteorological sensor assembly (which measures ambient air temperature ambient air pressure, cross wind velocity and head wind velocity)
- (d) fire-control computer which calculates the firing solution from manually input and automatic input data sources
- (e) loader's display panel (which displays ammunition types and selection)
- (f) gunner's control handle
- (g) amplifier box unit
- (h) amplifier input/output logic and signals distribution box
- (i) gun linkage mechanism
- (j) gyro box



Schematic of T-55 MBT showing position of main components of SUV-T55A Tank Fire-Control System

- (k) azimuth speed transmitter
- (I) elevation sensor
 - A typical moving target engagement cycle would be:
- (a) The tank commander detects the target and presses the target acquisition button; the turret swings around to align the gunner's line-of-sight with the commander's cupola position (typical time taken for acquisition phase is two seconds)

- (b) The gunner takes over the engagement by tracking the target and operates his laser rangefinder to establish the range (typical time taken for tracking phase is six seconds); this is then displayed in his optics and fed to the computer; a firing solution is computed from all the data inputs and the calculated superelevation and lead angles continuously fed to the gun laying system; the sight deflection system simultaneously counter rotates in order to maintain the line-of-sight to the target; the gunner then fires the main armament (typical time taken for firing phase is six seconds)
- (c) Further firing of rounds against the target can thereafter take place very rapidly as the lead angles are still being calculated.

The engagement procedure is the same for whether the firing platform is moving or stationary.

Variants

SUV-M84 intended for the Yugoslavian M-84 MBT. All the main tactical usage and technical data of the SUV-T55A remain valid for the SUV-M84. SUV-T72 intended for upgrading of the T-72 MBT and derivatives. The

system is based on the SUV-T55A and SUV-M84 models with the only difference being that the integrated day/night sight has been split into two sub-units: a gunner's day sight with built-in laser rangefinder and a gunner's night sight with either a passive night image intensifier or thermal imager.

SUV-60 intended for upgrading of the American M60 MBT. SUV-CH intended for upgrading of the British Chieftain MBT.

Status: Production as required. In service with unspecified countries.

Manufacturer: Rudi Čajavec, Defence Electronics, 78000 Banja Luka, Bracé Pavlicá 23A, Yugoslavia (Serbia/Montenegro).

Telephone: (078) 46 707 Fax: 33482

Enquiries to: Federal Directorate of Supply and Procurement (SDPR), 9 Nemanjina Street, 11105 Belgrade, Yugoslavia (Serbia/Montenegro). Telephone: +38 11 621522 Telex: 11360 Fax: +38 11 325403

SPECIFICATIONS Day/night gunner's sight MAGNIFICATION day night FIELD-OF-VIEW day night LASER RANGEFINDER TYPE WAVELENGTH MAX RANGE ACCURACY	× 7 and × 3 × 8.5 9° and 20° 5.5° Nd-YAG 1.064 μm 10 000 m ±5 m	Computer NUMBER OF AMMUNITION TYPES AIR TEMPERATURE AIR PRESSURE POWDER TEMPERATURE CROSSWIND VELOCITY HEADWIND VELOCITY TILT RANGE LIMITS laser manual	6 15°C (range -45°C to +50°C) 750 mm Hg (range -300 to + 100 mm Hg) 15°C (range -45°C to +50°C) ±40 m/s ±40 m/s ±15° 200-6000 m 200-9400 m
IMAGE INTENSIFIER TYPE	second-generation tube	LEAD ANGLE SUPERELEVATION	\pm 45 mils -10 to +70 mils
Thermal imager option			
WAVEBAND FIELD-OF-VIEW	7.5-11.8 μm	Gun control system TARGET TRACKING VELOCITY	
wide	5.1° × 12°	max azimuth speed	±80 mils
narrow DETECTOR TYPE	1.7° × 4° HgCdTe	max elevation speed GUN/TURRET VELOCITY	±40 mils
NUMBER OF ELEMENTS	60	max azimuth speed	±300 mils
COOLING SYSTEM DISPLAY	Stirling closed cycle CRT	max elevation speed	±80 mils

Land Navigation Systems

CANADA

Computer Devices Canada Commander's Display Panel

Development/Description

The Commander's Display Panel (CDP) has been developed by Computing Devices Canada to provide the tank commander with a versatile and simple interface for the display of digitised terrain maps, tactical information and navigation data.

It is also used for the composition, transmission and receipt of formatted messages and the display of vehicle status reports. These functions are achieved through the use of a 203 mm × 203 mm EL panel with a touch sensitive overlay to implement a number of software programmable function switches. Four dedicated hard switches for discrete functions complement the EL panel.

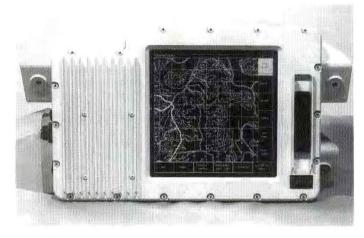
Status: Development complete (one built for demonstration purposes). Ready for production.

Manufacturer: Computing Devices Canada, PO Box 8508, Ottawa, Ontario, Canada K1G 3M9

Telephone: (613) 596 7000

Telex: 053-4139

Fax: (613) 820 5081



Computing Devices Canada Commander's Display Panel (CDP)

COMMONWEALTH OF INDEPENDENT STATES

TNA-4 Tank Navigation Apparatus

Development/Description

The TNA-4 is the latest land navigation system on which information has become available. It is similar in appearance to the earlier TNA models although some switches and displays have been omitted. A track recorder unit, not found on the previous systems, is also fitted.

The main components are:

- (a) gyro unit
- (b) distribution box
- (c) pulse transformer

- (d) power supply and transformer unit
- (e) speed indicator/distance measurement unit
- (f) course heading indicator unit
- (g) control unit
- (h) combined display/computer unit
- (i) track recorder map display

Status: Production. In service with the CIS and selected allies.

Manufacturer: Former Soviet state factories.

FRANCE

Sextant Avionique ARVERNE (APX M539) Magnetic Heading Indicator System

Development/Description

The ARVERNE magnetic heading indicator system was developed under a DTAT/AMX-APX contract and adopted by the French Army under the designation APX M539. It is designed for use mainly on armoured vehicles and has been tested on and fitted to such vehicles as the AMX-30, AMX-32, Leopard 1, M48 and M60 MBTs, Panhard VTT, AMX-10 and RVI VAB APCs, and the various Panhard, AMX-10RC and Renault armoured car and light reconnaissance vehicle families.

The system consists of three components:

1) an externally mounted cylindrical sensor unit which contains a magnetic detector, an attitude detector, the associated electronic circuits and the compensation and power supply circuits. The siting of the sensor is determined at the start of a vehicle fit programme by magnetic mapping measurements to find the best possible location in relation to any existing magnetic disturbances and essential access or user constraints. If the vehicle is modified during its life the mapping has to be redone and the sensor relocated accordingly

2) a display unit for the vehicle commander into which the corrected sensor output signal is fed to control the movement of the compass dial card on which the magnetic heading of the vehicle can be read against a fixed index mark which represents the vehicle axis.

The operator also has a manual control for setting the heading to steer and an electrical output signal representing the deviation between the actual heading of the vehicle and the preset heading which can then, for example, be used to control a simple right/left steering device to correct the course or be fed into other systems

3) a junction box, which provides the link between the sensor unit and the display unit as well as providing the interface for the electrical connection of the subsystem units to the 28 V DC vehicle supply

The operating principle of the ARVERNE relies on the fact that any armoured vehicle creates a series of magnetic disturbances or anomalies



Main components of the Sextant Avionique ARVERNE magnetic heading indicator system, from left to right, display unit, junction box and sensor unit

around it because of its ferrous structure and the electrical operations carried out within it. Thus a fluxgate type magnetometer is used in the sensor whereby corrections are made, using coefficients calculated in magnetic field along the main axes of the vehicle. Because the data generated by it are distorted by the spurious magnetic disturbances around the vehicle, the raw information is fed into the electronics section of the sensor whereby corrections are made, using coefficients calculated in advance during the compensator phase of the system installation. The electronics also compensate for the effects of the slant of the vehicle using data obtained from the attitude detector measurements. Once all the corrections are made, the signals representing the actual heading of the vehicle are sent to the display unit.

By adding other modular components the navigation system configurations, NAVYX (qv) and SYDADE (qv), can be obtained.

SPECIFICATIONS

WEIGHT

4 kg sensor unit display unit 1 kg junction box 1 kg

DIMENSIONS sensor unit

diameter 150 mm height 205 mm

100 × 100 × 100 mm display unit 172 × 147 × 41 mm iunction box POWER SUPPLY 28 V DC vehicle supply

Status: Production. In service with the French Army and other unspecified

Manufacturer: Sextant Avionique, Navigation Systems Division, 25 rue Jules Vedrines, F-26027 Valence Cedex, France.

Telephone: (33) 75 79 85 11 Telex: 345807 F Fax: (33) 75 56 43 37

Sextant Avionique NAVYX Position Determining System

Development/Description

The NAVYX system configuration for military vehicles is obtained by adding the two complementary modules that form the NAVYX position determining equipment to the ARVERNE (qv) magnetic heading indicator system. The modules comprise:

- 1) a processing and display unit, which is designed to be electrically interchangeable with the display unit of the ARVERNE heading indicator, and consists of:
- a) a control dial for displaying the average magnetic variation of the area through which the vehicle is travelling. The display reads between 400 mils East and West with a resolution of 10 mils (or can optionally be graduated in degrees with limits of ±25° and 0.5° resolution)
- b) a moving compass dial on which the heading is read in front of a fixed index
- c) two 4-digit numerical displays which are graduated either in kilometres (up to 99.99 along each axis) or miles (again up to 99.99 along each axis). The heading value supplied by the ARVERNE indicator is a magnetic heading, so the processing and display unit uses the set variation to calculate a corrected heading in order to find the vehicle's position in terms of X-Y co-ordinates



Main components of Sextant Avionique NAVYX Position Determination System

- d) two controls for re-adjusting the co-ordinates, which are used particularly for presetting the starting position
 - e) a setting device for the heading to be followed
- 2) a distance transmitter or odometer, which measures the rotation of the transmission shaft that transmits movements directly to the driving wheel or to the sprocket wheel of the vehicle. It then delivers a characteristic electrical signal representing the distance travelled, typically one pulse per metre or thousandth of a mile. The scale factor of the sensor is calibrated for the type of vehicle when the instrument is fitted. However, this fitting may not be necessary if the vehicle already has a distance travelled sensor installed which is compatible with the NAVYX system and has the desired accuracy of around 1%

All the operator has to do on start-up is set the magnetic variation, the starting position and, when required, the heading to be followed. The system will then provide the information as detailed.

SPECIFICATIONS

4 kg
1 kg
1 kg
1.7 kg

processing and display 3 kg

DIMENSIONS diameter 150 mm heading sensor unit height 205 mm heading junction box 172 × 147 × 41 mm

heading display unit 100 × 100 × 100 mm (optional) distance transmitter unit diameter 60 mm length 120 mm

processing and display POSITION ACCURACY

HEADING ACCURACY

POWER SUPPLY

 $180\times120\times110~mm$

between 1 and 3% of distance travelled depending on vehicle type between 1 and 3° depending on vehicle

type

28 V DC vehicle supply

Status: Production. In service with the French Army and other unspecified

Manufacturer: Sextant Avionique, Navigation Systems Division, 25 rue Jules Vedrines, F-26027 Valence Cedex, France

Telex: 345807 F Fax: (33) 75 56 43 37 Telephone: (33) 75 79 85 11

Sextant Avionique SYDADE Land Navigation Aid System

Development/Description

The Sextant Avionique SYDADE dead-reckoning land navigation aid system configuration for military vehicles is obtained by adding the distance transmitter unit of the NAVYX (qv) position determining equipment to the ARVERNE (qv) magnetic heading indicator system and then coupling both to a system-crew interface unit.

The latter is designed to be electrically interchangeable with either the display unit of the heading indicator or the processing and display unit of the NAVYX system. The unit uses the distance information and the magnetic heading data, generated by the respective subsystems to continuously update the current position of the vehicle in an X-Y co-ordinate system after prior setting of the start position, and displays this information together with the vehicle heading.

It can also be used for navigation towards a fixed waypoint by bearingdistance measurements, and for triangulation calculations whenever the operator wishes to obtain a waypoint from information sent by an external observer at some distance from the vehicle

The front panel of the system-crew interface unit has the following controls/displays:

- 1) a selection switch for system settings and functions
- 2) a keyboard for inputting parameter information



Sextant Avionique SYDADE Land Navigation Aid System components

3) two 4-digit numerical display windows for parameter presentation: present position (X-Y co-ordinates); waypoint (X-Y co-ordinates); waypoint bearing and distance; updating position; observer position; waypoint coordinates with respect to observer

414 LAND NAVIGATION SYSTEMS / France

4) a 4-digit numerical display window for: heading steered; heading to steer; magnetic variation

5) an illuminated left or right arrow display showing the right or left error between heading steered and heading to steer, or between the heading steered and waypoint bearing.

All the operator has to do on start-up is preset the magnetic variation, the starting position, the heading to be steered when applicable, and the waypoint, when applicable. The system will then provide the information as

SPECIFICATIONS

WEIGHT

heading sensor unit 4 kg heading junction box 1 kg heading display unit (optional) 1 kg

distance transmitter unit

system-crew interface

4 kg unit

DIMENSIONS

heading sensor unit diameter 150 mm height 205 mm 172 × 147 × 41 mm

junction box heading display unit

(optional) distance transmitter

system-crew interface

unit

POSITION ACCURACY

HEADING ACCURACY POWER SUPPLY

220 × 140 × 120 mm

100 × 100 × 100 mm

diameter 60 mm

length 120 mm

between 1 and 3% of distance travelled

depending on vehicle type

between 1 and 3° depending on vehicle type 28 V DC vehicle supply

Status: Production. In service with the French Army and other unspecified countries.

Manufacturer: Sextant Avionique, Navigation Systems Division, 25 rue Jules Vedrines, F-26027 Valence Cedex, France

Telephone: (33) 75 79 85 11 Telex: 345807 F Fax: (33) 75 56 43 37

SAGEM NSM 20 Land Navigation System

1.7 kg

Development/Description

The NSM 20 Land Navigation System (LNS) is designed to perform the functions of autonomous North finder, heading reference and self-contained navigator for wheeled or tracked vehicles.

Its compact and rugged modular design allows it to be operated in all environmental and operating conditions, including EMP. It provides guick and accurate azimuth self-alignment and initial heading preservation, and

3D navigation by position updating on the move, computing route planning information and calculating headings and distances

The system comprises just three units:

- (a) Inertial Navigation Unit (UNI) when directly mounted on a gun, missile or rocket launcher the UNI can also provide elevation data as well as azimuth and position
- (b) Distance Travelled Meter (MDP)
- (c) Handheld Terminal (TPO) this manages the NSM 20 control and data display. It can either be operated from a fixed spot on the vehicle or from anywhere inside or outside the vehicle. The TPO is a processor controlled terminal which displays navigation data as well as its own operating menu, thus eliminating the need for an extra operating manual.

An altimeter (ALT) and a secondary Driver Direction Unit are optional items. The NSM 20 can be remotely controlled through standard interfaces (for example RS 422) and be coupled to other systems such as a Day and Night Observation Cupola or weapon fire-control system.

It is fitted with Built-In Test Equipment (BITE), operates with all coordinate systems and can be interfaced to a Global Positioning Satellite (GPS) system. Special instructions enable the operator to run system maintenance procedures and conduct a comprehensive NSM 20 functional analysis

10 m CEP plus 0.2% of distance travelled

SPECIFICATIONS

ALIGNMENT

POSITION ACCURACY ALTITUDE ACCURACY REFERENCE DIRECTION STORAGE AZIMUTH SELF

0.7 mil/h

1 mil (1 sigma)

10 m (1 sigma)

Status: Production. In service with the French Army and several other unspecified countries on 12 different types of vehicle.

Manufacturer: SAGEM, Départment Navigation, Aéronautique et Terrestre,

6 avenue d'Ièna, F-75783 Paris Cedex 16, France. Telephone: 33 (1) 40 70 63 63 Telex: 205255 F Fax: 33 (1) 40 70 67 24



Main components of SAGEM NSM 20 Land Navigation System

SAGEM CITA 20 Navigator and Inertial Goniometer

Development/Description

The CITA 20 navigator and inertial goniometer unit has been developed by SAGEM from the NSM 20 land navigation system and is fitted to the 155 mm AUF 1 self-propelled guns of the French Army to provide automatic and immediate orientation of the vehicle at a firing position, without the need to pre-survey landmarks.

The orientation and position data computed by the CITA 20 is digitised and can, therefore, be sent to a centralised or autonomous artillery automation system.

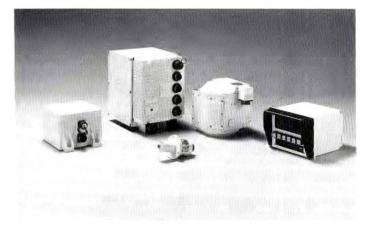
CITA 20 can also be fitted to other artillery systems such as the 155 mm M109 self-propelled howitzer series and the 227 mm Multiple Launch Rocket System (MLRS) to give them the same accurate, immediate and autonomous firing capability.

The system comprises five modules including an odometer unit and provides the same functions as the NSM 20.

Status: Production. In service with the French Army.

Manufacturer: SAGEM, Départment Navigation Aéronautique et Terrestre, 6 avenue d'Iéna, F-75783 Paris Cedex 16, France.

Telephone: 33 (1) 40 70 63 63 Telex: 205255 F Fax: 33 (1) 40 70 67 24



Main components of SAGEM CITA 20 Navigator and Inertial Goniometer

SAGEM SIGMA 30 Ring Laser Gyro Inertial Navigation System

Development

The SIGMA 30 is designed to be used with platforms such as long-range anti-aircraft artillery which need accurate precision heading and positioning data. The equipment also suits any application requiring short reaction time, severe environmental operating condition qualification and low-life cycle costs.



SAGEM SIGMA 30 ring laser gyro inertial navigation system

The alignment and navigation functions are performed through a unique and optimised Kalman filtering of multi-sensor data, increasing inertial odometric and zero velocity information. All sensor calibrations are automatic.

Description

The SIGMA 30 comprises the following subsystems:

- (a) Inertial Navigation Unit
- (b) a handheld terminal which manages the SIGMA 30 control and data display
- (c) an odometer (optional)

A SAGEM GPS/NAVSTAR receiver can be embedded into the Inertial Navigation Unit itself or interfaced as an external unit.

To achieve its performance characteristics the SIGMA 30 combines the use of user friendly control with the latest generation Ring Laser Gyro device, with a high performance accelerometer specially adapted to strapdown usage.

This provides for all long-range artillery navigation requirements, including 3D inertial navigation, an absolute and accurate weapon aiming/laying capability over the platform's whole elevation range, and Zero Velocity Update (ZUP).

SPECIFICATIONS

HORIZONTAL ACCURACY 10 m + 0.15% of the distance travelled

(without Zero Velocity Update)
5 m + 0.1% with Zero Velocity Update

every 10 min

AZIMUTH ACCURACY 0.8 mil PITCH AND ROLL ACCURACY 0.6 mil

GPS OPTION C/A and P codes

Status: Pre-production.

VERTICAL ACCURACY

Manufacturer: SAGEM, Départment Navigation Aéronautique et Terrestre,

6 avenue d'Iéna, F-75783 Paris Cedex 16, France.

SAGEM ULISS 30 Position and Azimuth Determination System (PADS)

Development/Description

The ULISS 30 PADS has been designed to meet high accuracy survey and field artillery requirements.

It comprises the following subsystems:

- (a) INU 30 a full self-contained Inertial Navigation Unit (INU) with a three axis inertial platform containing dry tuned gyros
- (b) CDU 30 a separate hand-held control and display unit

The system outputs the following:

- (i) North (finding and keeping)
- (ii) Azimuth (true and grid North) (iii) Navigation aids (steering)

SAGEM ULISS 30 Position and Azimuth Determination System (PADS)

- (iv) Orientation reference for optical transfer (prism or mirror)
- (v) Accurate 3-axis position, in both the geographical or UTM grid coordinates and altitude.

At switch-on the ULISS 30 recovers its last measured position or receives a new one entered through the CDU and finds the North autonomously. It is then fully operational with platform position, azimuth and navigation aids continuously computed and displayed on the CDU from then on.

For geodesy, mapping and other survey applications the high standard of accuracy required is obtained through automatic velocity updates to correct the accumulated errors whenever the vehicle stops. The system detects the standstill period, switches to velocity update below a programmable threshold of immobility and then reverts to navigation when the vehicle is again in motion.

The ULISS 30 can be transferred from one platform to another, whilst maintaining continuous operation and spot control of previously inaccessible areas. Remote positioning is also made possible through its optional equipment range and azimuth meter.

SPECIFICATIONS

WEIGHT 45 kg

DIMENSIONS 520 × 490 × 260 mm

POWER SUPPLY 18 to 31 V DC

LATITUDE RANGE 75° N to 75° S

ACCURACY (following apploard mission processing

ACCURACY (following onboard mission processing):

Survey mode for traverses up to 15 km (with 4 min period velocity updates) ±0.5 m CEP on the three axes Artillery mode for traverse up to 75 km

Artillery mode for traverse up to 75 km (with 10 min period velocity updates)

±2 m CEP on the three axes ± 0.5 mil CEP on heading

Status: Production.

Manufacturer: SAGEM, Département Navigation Aéronautique et Terrestre, 6 avenue d'Iéna, F-78783 Paris Cedex 16, France.

SFIM SILVER Strapdown Attitude and Heading Reference System (AHRS)

Development/Description

The SILVER strapdown AHRS is specifically intended for use by MBTs and mobile anti-aircraft weapon systems. It uses dynamically tuned GAM 1-GL gyroscopes ensuring initial alignment with the vehicle at rest before providing continuous heading and attitude references whilst it is in motion.

Initialisation and resetting are achieved by electrolytic levels.

SPECIFICATIONS

OUTPUT

ALIGNMENT ACCURACY VERTICAL REFERENCE HEADING REFERENCE ACCURACY POWER SUPPLY

0.5° after 5 mins measurement 5 mils 10 mils/h

18 to 30 V DC RS422 (two directions)

Status: Pre-production.

Manufacturer: SFIM Industries, F-91344 Massy Cedex, France. Telephone: (1) 69 20 88 90 Telex: 602 164 Fax: (1) 69 20 28 13

SFIM SILVER Strapdown Attitude and Heading Reference System



SFIM SILVERNAV Land Navigation System

Development/Description

The SILVERNAV land navigation system is derived from the SILVER Attitude and Heading Reference System by the simple addition of a computer to ensure odometer acquisition and navigation computations. It is currently being evaluated by French Ministry of Defence.

As an option a Global Positioning Satellite (GPS) device can be interfaced

As an option a Global Positioning Satellite (GPS) device can be interfaced to ensure automatic resetting of the navigational computer.

SPECIFICATIONS

ALIGNMENT ACCURACY
VERTICAL REFERENCE
HEADING REFERENCE ACCURACY
POWER SUPPLY
OUTPUT
NAVIGATION ACCURACY

0.5° after 5 mins measurement 5 mils 10 mils/h 18 to 30 V DC RS422 (two directions) 1% of distance travelled

Status: Under evaluation by the French MoD.

Manufacturer: SFIM Industries, F-91344 Massy Cedex, France. Telephone: (1) 69 20 88 90 Telex: 602 164 Fax: (1) 69 20 28 13

GERMANY

Bodenseewerk GPA 2000 Gun Positioning and Laying System

Development

The GPA 2000 has been developed using the in-service experience derived from the BGT FNA 615 Vehicle Navigation System. It is designed for use as a land navigation and attitude reference system and gives precision determinations of present position (UTM co-ordinates plus altitude) and attitude (azimuth, elevation and cant angle) for gun positioning and laying.

It has been selected for the future German Army's self-propelled howitzer, PzH 2000, and can also be used as an update package for fielded systems such as the American M109 family.

Description

The GPA 2000 comprises the following subsystems:

(a) Heading and Attitude Reference Unit (HARU) – which represents an autonomous heading and attitude platform with self alignment capability. The associated electronic and navigation/fire-control computer is based on the 80286/80287 microprocessor. For North alignment by gyrocompassing and heading one Dynamically Turned Gyro (DTG) is contained in the platform.

This gyro technology has already been proven in the FNA 615 system with an MTBF of more than 100 000 hours (based on approximately one million operating hours logged).

The electronics are based on the latest Surface-Mounted Devices (SMD) whilst the HARU is contained within a ruggedised and shielded housing.

(b) Fire-Control Unit (FCU) – which consists of a programmable keyboard, a high contrast illuminated LCD (with eight lines of 20 characters), a computer board, a power supply board and an interface board in a dust and watertight housing.

(c) Distance Transmitter Unit (DTU) – which consists of an electro-optical transducer and associated electronics.

The GPA 2000 will perform the following functions:

(a) autonomous determination of geographic/grid North by gyrocompassing

 (b) continuous determination of present vehicle position in UTM-East and UTM-North co-ordinates

(c) continuous determination of present vehicle altitude

 (d) continuous determination of present attitude, ie azimuth, elevation and cant angle

(e) continuous self-test of hardware and software before, during and after operational use by means of Built-In Test Equipment (BITE) and test methods.

These functions are menu-controlled by the FCU via a standard RS422 interface.

SPECIFICATIONS (typically installed in an M109)

NORTH DIRECTION ACCURACY ≤1 mil (RMS) GYRO DRIFT ≤0.5 mil/h POSITIONAL ACCURACY

travel distance 4 km ≤10 m (2nd RMS)

travel distance 4 km ≤0.25% of distance travelled ALTITUDE ACCURACY

travel distance 10 km ≤10 m (2nd RMS)
travel distance 10 km ≤0.1% of distance travelled
ATTITUDE ACCURACY

(for 65° elevation and 30° cant angles) ≤1 mil POWER SUPPLY 24 V DC POWER CONSUMPTION

warm-up phase (1-2 min) 230 W operation 70 W

Status: Entering pre-production and series production phases. On order for German Army (PzH 2000 application).

Manufacturer: Bodenseewerk Gerätetechnik GmbH, PO Box 101155, D-7770 Überlingen, Federal Republic of Germany.

Telephone: (07551) 89-0 Telex: 733924 Fax: (07551) 89-2822



Bodenseewerk GPA 2000 Gun Positioning and Laying System

Bodenseewerk FNA 615 Vehicle Navigation System

Development

The FNA 615 was developed by Bodenseewerk for the German Federal Ministry of Defence as a high precision vehicle navigation system for exact position fixing during target survey work. It was proven in extensive field trials at the beginning of the seventies and procured as part of the equipment fit for 320 M113A1G Beobachtungs-Panzer Artilleries (artillery observation vehicles) built between 1982-85.

The FNA 615 can also be used on other vehicle types such as scout cars. reconnaissance vehicles, self-propelled missile systems and mine warfare vehicles.



Main components of the Bodenseewerk FNA 615 vehicle navigation system

Description

In German Army service, the FNA 615 is integrated with a telescopic sight and laser rangefinder assembly to accurately compute the target coordinates so that they can be transmitted to an artillery fire-control centre via a data link terminal.

The specific vehicle position can also be indicated at all times in UTM coordinates. The direction and distance to a preselected target point can be indicated on the system display and control unit to the vehicle's artillery observer crew, with the driver having the same information presented to him on a secondary display unit.

The FNA 615 comprises the following subsystem assemblies:

- a) gyro reference unit, which includes a meridian gyro for the rapid automatic determination of North (at the beginning of a mission) and a highprecision directional gyro for storing the North direction and indicating the direction of the travelling vehicle
- b) a 5 kilobyte (optional 32 kilobyte) navigation computer, which performs the navigation calculations and translates the resultant information into coordinate data. A software program is included which automatically detects and compensates for any navigation errors
- c) display and control unit, which is used to input the vehicle's initial position, display the specific vehicle position and/or continuously display the distance to a preselected navigation point
- d) gyro electronics unit, which includes all the control systems and amplifiers required for the operation of the gyro reference unit
- e) secondary display unit, which displays the direction and distance to target and can be located either at the vehicle driver or commander station
- f) electronic distance meter (or odometer), which is used to measure the distance travelled by the vehicle
- g) power supply unit, which transforms the vehicle power supply into all the voltages necessary to operate the individual subassemblies
 - h) interconnecting cable set.

In operation the FNA 615 is fully automatic and is ready for operation within five minutes of switch-on. This preparatory time includes that needed for the gyro run-up and the four minutes required before the meridian gyro automatically determines North. The same accuracy of North alignment measurement can be attained 1.5 minutes after a repetition measurement.

Stops during the drive for position corrections are not required but, if made, the stored failure software correction program can be used to considerably enhance the navigation accuracy.

If the system is switched off or a power failure occurs the stored information is retained for future use and not lost.

SPECIFICATIONS

approximately 35 kg WEIGHT (total system) NAVIGATION ACCURACY 0.32% CEP POWER SUPPLY 24 V DC

Status: Production as required. In service with the German Army (on M113A1G artillery observation vehicles).

Manufacturer: Bodenseewerk Gerätetechnik GmbH, PO Box 101155, D-7770 Überlingen, Federal Republic of Germany

Telephone: (07551) 89-0 Telex: 733924 Fax: (07551) 89-2822

Teldix Vehicle Navigation Systems

Development/Description

The German firm of Teldix GmbH is marketing a modular configuration concept for vehicle-mounted autonomous, cost-effective orientation and navigation systems.

The basic subsystems are:

- 1) ABG 50 Control-Display-Unit
- EWG 50 Distance Transmitter
- FAG 50 Driver's Indicator
- KG 25 Map Display Unit KGS 90 Tracking Plotter
- KH 25 Map-Display-Unit-Holder
- KK 25 Directional Gyro
- KK 50 Directional Gyro
- NSK 55 North Seeking Gyro.

Of these, the KGS 90 Tracking Plotter is an optional item for both the FOA and FNA modular systems. It is designed to receive data from navigation or radar systems and plot it onto an 800 × 400 mm map of selectable scale.

The information received can be used to establish:

- a) the distance travelled if it is derived from a Teldix GmbH navigation
- b) the plot of a moving radar target, the position and North reference supplied from either a Teldix or another land navigation system
 - c) radar shadow areas
- d) a digital readout (in UTM (geographic) co-ordinates) of plotted positions
 - e) precise radar antenna alignment for fixed-object surveillance
- f) a prediction of target reappearance after radar shadow penetration. Besides the plotting on maps the KGS 90 is also able to plot on other types of paper such as a transparent map overlay.

The equipment operates on the roller map principle, whereby the map



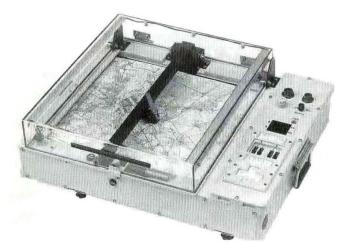
FOA 20 Vehicle Orientation System components

moves around two rollers, thus allowing the plotting of co-ordinates in the X-direction whilst those in the Y-direction are plotted by the moving plotter head assembly. All the plotter functions are controlled by a small microprocessor. The BITE built-in test program ensures the detection of malfunctions down to the subassembly level.

Another optional system is the FAG 50 Driver's Indicator which acts as a repeater unit and, depending on mode, continuously displays either the vehicle heading or the distance and bearing to destination/waypoint on its compass rose dial.

The various subsystems, equipped with compatible interfaces, can be combined to fit customer requirements such as:

- i) NKA 55 North-seeking Gyro System: $1 \times$ NSK 55, $1 \times$ ABG 50
- ii) FNA 50 Navigation System: $1 \times$ NSK 55, $1 \times$ KK 50, $1 \times$ EWG 50, 1 × ABG 50, optional FAG 50
- iii) FNA 55 Navigation System: 1 × NSK 55, 1 × KK 50, 1 × EWG 50, 1 x KG 25, optional FAG 50



KGS 90 Tracking Plotter unit



FAG 50 Driver's Indicator Unit (left) and ABG 50 Control/Display Unit (right)

- iv) FOA 50 Orientation/Survey System: 1 x KK 50, 1 x EWG 50, KG 25, optional FAG 50
- v) FOA 40 Orientation System: 1 x KK 50, 1 x EWG 50, 1 x ABG 50, optional FAG 50
- vi) FOA 25 Orientation System: 1 x KK 25, 1 x EWG 50, 1 x KG 25, optional FAG 50
- vii) FOA 20 Orientation System: 1 × KK 25, 1 × EWG 50, 1 × ABG 50, optional 1 × FAG 50.

The specifications for the FOA 20 and FOA 40 Orientation Systems are given below whilst the others are described in the following entries.

SPECIFICATIONS FOA 20 Orientation System

WEIGHT KK25 4.5 kg **EWG 50** 0.4 kg ABG 50 2 kg FAG 50 (optional) 1 kg DIMENSIONS

KK 25 243 × 152 × 152 mm **EWG 50** 62 × 62 × 65 mm **ABG 50** 246 × 99 × 126 mm FAG 50 (optional) 109 × 145 × 52 mm

POSITION ACCURACY $CEP \le 2\%$ of distance travelled at update

intervals of ≤ 20 mins

POWER SUPPLY 24 ± 6 V DC vehicle supply

FOA 40 Orientation System

WEIGHT KK 50 6 kg EWG 50 0.4 kg ABG 50 2 kg FAG 50 (optional) 1 kg DIMENSIONS

KK 50 284 × 172 × 190 mm **EWG 50** $62 \times 62 \times 65 \text{ mm}$ 246 × 99 × 126 mm **ABG 50** 109 × 145 × 52 mm FAG 50 (optional)

POSITION ACCURACY CEP ≤ 0.4% to 1.2% depending on update

intervals (20 mins to 2 h)

POWER SUPPLY 24 ± 6 V DC vehicle supply

KGS 90 Plotting System

DIMENSIONS 640 × 530 × 192 mm

MAP SCALES 1:25 000, 1:50 000, 1:100 000 (other scales on

request) 400 × 400 mm

MAP DISPLAY AREA MAP DISPLAY ACCURACY ± 1 mm (3 sigma)

Status: All Teldix GmbH Navigation/Orientation subsystems are in production and in service with several unspecified countries

Under development is an Autonomous Vehicle Orientation/Naviation System with GPS support.

Manufacturer: Teldix GmbH, PO Box 105608, Grenzhöfer Weg 36, D-6900 Heidelberg 1, Federal Republic of Germany.

Telephone: (06221) 512-300 Telex: 461735 Fax: (06221) 512-540

Teldix NKA 55 North-seeking Gyro System

Development/Description

The vehicle-mounted Teldix NKA 55 North-seeking Gyro System consists of the following subsystems:

1) ABG 50 Control-Display-Unit, which is operated from a keyboard. with the data being indicated on an LCD panel.

The LCD panel comprises a compass rose which indicates course vehicle heading, a display section which shows on request the mode of operation, and the following data:

- a) the grid heading, which is the angle between the gyro housing and the UTM grid North
- b) the true heading, which is the angle between the gyro housing and the geographic North
 - c) a figure of confidence for the data
 - d) the entered UTM position co-ordinates (Eastings and Northings)
 - e) maintenance and adjustment values.
- 2) NSK 55 North-seeking gyro, which incorporates a horizontal-spinaxis gas-bearing gyro that is capable of measuring very small angular velocities. The rate gyro is accommodated in a gimballing device and aligned to the local vertical by a positioning device irrespective of the vehicle's tilt angle. A high-precision stepper motor turns the rate gyro into discrete azimuth positions and thus allows the sensing of components of the Earth rate vectors in the horizontal plane. A microprocessor calculates from the Earth rate components the angle between the true North and the gyro housing reference. On vehicles the latter corresponds to the vehicle's longitudinal axis and on radar antennas to the antenna axis. Thus, true heading is made available to the system.

By entering the UTM co-ordinates of the vehicle position (Eastings and Northings), the meridian convergence (or the angle between geographic North and the UTM grid North) is calculated. Thus grid heading is obtained

Depending upon environmental conditions the NSK 55 has the potential to an accuracy of 1 mil which equates to 0.06°

3) vehicle specific cable connection set.

In operation the system automatically senses the geographic North within two minutes. However, in order to achieve an accurate reading the vehicle must be at standstill during this alignment phase and on ground with not more than 15° of inclination. A figure of confidence value displayed for the attained North reference value indicates the system accuracy.

SPECIFICATIONS

WEIGHT

2 kg ABG 50 **NSK 55** 8 kg

DIMENSIONS

ABG 50 246 × 99 × 126 mm **NSK 55** 302 × 173 × 228 mm

HEADING RESOLUTION

compass rose 200 mils

digital readout 1 or 0.1 mils (selectable on 6400 mil scale) 0.1 or 0.01° (selectable on 360° scale)

NORTH REFERENCE up to 1 mil (1 sigma) depending ACCURACY on environmental conditions

NORMAL OPERATING ±70° latitude

POWER SUPPLY 24 ± 6 V DC vehicle supply

Status: Production. In service with unspecified countries.

Manufacturer: Teldix GmbH, PO Box 105608, Grenzhöfer Weg 36, D-6900 Heidelberg 1, Federal Republic of Germany.

Telephone: (06221) 512-300 Telex: 416735 Fax: (06221) 512-540

Teldix FNA 50 Vehicle Navigation System

Description

The Teldix FNA 50 Vehicle Navigation System consists of the following subsystems:

1) ABG 50 Control-Display-Unit

2) KK 50 Directional Gyro, which has two degrees of freedom and senses any change in the vehicle heading related to the heading reference attained by the NSK 55. The output signals are corrected for various drifts and the meridian convergence in a microprocessor. The resulting grid heading of the vehicle is used for navigational computations

3) NSK 55 North-seeking gyro for North referencing

4) EWG 50 Distance Transmitter, which is directly connected either to the vehicle transmission or to a vehicle wheel via a flexible shaft. It furnishes distance travelled data in the form of electrical signals to the Directional Gyro

5) vehicle specific cable set.

The operational principle is that the combination of the North-Seeking Gyro and the Directional Gyro furnishes the heading reference information whilst the Distance Transmitter provides the distance travelled.

The microprocessor of the ABG 50 processes these data to obtain the respective East/West and North/South components of a mission. The latter are continuously added to the preset starting point co-ordinates so that the vehicle's present position co-ordinates are indicated on the LCD panel in the form of Eastings and Northings with a 1 m resolution.

The digital data output of both the ABG 50 and the NSK 55 can, in terms of vehicle (grid) heading and position in UTM grid co-ordinates, also be transferred to other systems for further processing.

The major data are stored in a battery-buffered RAM and are thus retained for subsequent use after switch-off and on again. A BITE (Built-In Test Equipment) monitors all system functions. In the event of a malfunction, the defective subassembly is indicated on the LCD panel of the ABG 50.

For the North alignment phase the vehicle must be at a standstill on ground with not more than 15° of inclination.

SPECIFICATIONS

WEIGHT **ABG 50** 2 kg KK 50 6 kg **NSK 55** 8 kg **EWG 50** 0.4 kg FAG 50 (optional) **DIMENSIONS**

ABG 50 246 × 99 × 126 mm KK 50 284 × 172 × 190 mm NSK 55 302 × 173 × 228 mm 62 × 62 × 65 mm **FWG 50** FAG 50 (optional) 109 × 145 × 52 mm

NAVIGATIONAL ACCURACY CEP < 0.35 to < 0.45% depending upon

temperature range

POSITION RESOLUTION 1 or 10 m HEADING RESOLUTION

compass rose 200 mil

1 or 0.1 mil (selectable on 6400 mil scale) digital readout 0.1° or 0.01° (selectable on 360° scale)

NORMAL OPERATIONAL AREA + 70° latitude

POWER SUPPLY 24 ± 6 V DC vehicle supply

Status: Production. In service with unspecified countries.

Manufacturer: Teldix GmbH, PO Box 105608, Grenzhöfer Weg 36, D-6900 Heidelberg 1, Federal Republic of Germany. Telephone: (06221) 512-300 Telex: 461735 Fax: (06221) 512-540

Teldix FNA 55 Vehicle Navigation System

Description

The Teldix FNA 55 Vehicle Navigation System consists of the following

1) KG 25 Map Display Unit, which controls and operates the system using a keyboard, an LCD panel with compass rose dial and a 240 × 240 mm map display area

The latter has integral cross-wires in its hinged transparent cover which move over the map to continuously indicate the vehicle position. Maps with different scales from 1:10 000 up to 1:500 000 can be used and are illuminated on the map display area.

A system mode selection enables the following data to be displayed on

a) vehicle heading in mils or degrees, 6400 mil or 360° display (other scales are available on request)

b) vehicle position in UTM co-ordinates with a selectable resolution of either one or 10 m

c) vehicle heading on the compass rose with coarse 200 mil resolution

d) the distance and bearing of up to 50 destinations/waypoints

e) the East-West and North-South distances of up to 26 reference points

f) the selected mode for system operation, map scale and position update

g) maintenance information in the form of defective subassemblies

2) KH 25 Map-Display-Unit Holder

3) NSK 55 North-Seeking Gyro

4) KK 50 Directional Gyro

5) EWG 50 Distance Transmitter

6) vehicle specific cable set.

The operating principle is that the combination of North-Seeking Gyro and the Directional Gyro provide the heading reference while the Distance Transmitter provides the distance travelled data. The microprocessor of the KG 25 processes these data such as to obtain the respective East/West and North/South components of a mission. The latter are continuously added to the preset starting point co-ordinates so that the vehicle's present position co-ordinates are indicated continuously by the cross-wires on the map. A coarse heading reading is continuously given on the compass rose. On request a digital readout of either the heading or the position coordinates is indicated on the LCD panel.

The mode selection enables the relevant parameters, as described above, also to be displayed. A battery-buffered RAM stores the major information which is then retained for subsequent use after system switchoff. A BITE (Built-In Test Equipment) monitors all system functions. In case of malfunction the defective subassembly is indicated on the LCD panel of the KG 25

For the North alignment phase the vehicle must be at a standstill on ground with not more than 15° of inclination.

SPECIFICATIONS

WEIGHT KG 25 4.9 kg KH 25 1 kg **NSK 55** 8 kg KK 50 6 kg EWG 50 0.4 kg FAG 50 (optional) 1 ka DIMENSIONS

KG 25 395 × 305 × 54 mm KH 25 310 × 302 × 55 mm **NSK 55** 302 × 173 × 228 mm KK 50 284 × 172 × 190 mm FWG 50 62 × 62 × 65 mm FAG 50 (optional) 109 × 145 × 52 mm

NAVIGATIONAL ACCURACY CEP \leq 0.35 to \leq 0.45% depending upon

temperature range POSITION RESOLUTION 1 or 10 m

HEADING RESOLUTION compass rose

1 or 0.1 mil (selectable, on 6400 mil scale) digital readout 0.1 or 0.01° (selectable on 360° scale)

NORMAL OPERATING AREA ± 70° latitude

1:20 000, 1:24 000 SELECTABLE STORED MAP SCALES 1:25 000, 1:40 000 1:50 000, 1:100 000 1:200 000, 1:250 000 1:300 000, 1:400 000

FREE SELECTABLE SCALES 1:10 000 to 1:500 000 24 ± 6 V DC vehicle supply POWER SUPPLY

Status: Production. In service with unspecified countries.

Manufacturer: Teldix GmbH, PO Box 105608, Grenzhöfer Weg 36,

D-6900 Heidelberg 1, Federal Republic of Germany.

Telephone: (06221) 512-300 Telex: 461735 Fax: (06221) 512-540





KG 25

(Option)



Teldix FNA 55 Vehicle Navigation System components

Teldix FOA 25 and FOA 50 Vehicle Orientation Systems

Description

The Teldix FOA 25 Vehicle Orientation System consists of the following subsystems:

- 1) KG 25 Map Display Unit
- KH 25 Map-Display-Unit Holder
 EWG 50 Distance Transmitter
- 4) KK 25 Directional Gyro, that is similar in operation to the KK 50 model
- 5) vehicle specific cable set.

The FOA 50 system is very similar but has a more accurate KK 50 Directional Gyro in place of the smaller KK 25 unit.



Teldix FOA 25 Vehicle Orientation System components

The operating principle is the same for both systems. The Directional Gyro provides vehicle heading changes to the calculated grid North reference whilst the Distance Transmitter provides the distance travelled data.

The microprocessor in the KG 25 processes the information to obtain the respective East/West and North/South components of a mission. En route the heading information is referred to grid North and the two sets of components are added to the preset starting point co-ordinates. The vehicle's position is then continuously shown on the map by the cross-wires and on the LCD readout. The vehicle heading is indicated on the LCD display's compass rose dial. Basically, the same features of the FNA 55 are available, except the high accuracy North reference.

SPECIFICATIONS

SPECIFICATIONS	
WEIGHT	
KG 25	4.9 kg
KH 25	1 kg
EWG 50	0.4 kg
KK 25	4.5 kg
KK 50	6 kg
DIMENSIONS	
KG 25	395 × 305 × 54 mm
KH 25	304 × 302 × 55 mm
EWG 50	62 × 62 × 65 mm
KK 25	243 × 152 × 152 mm
KK 50	284 × 172 × 190 mm
POSITION ACCURACY	
FOA 25	CEP ≤ 2% of distance travelled
FOA 50	
orientation task	CEP ≤ 0.5-1.5% of distance travelled
	depending on update intervals
surveying task	CEP ≤ 0.4% of distance travelled
POSITION RESOLUTION	1 or 10 m
HEADING RESOLUTION	
compass rose	200 mils
digital readout	1 or 0.1 mil (selectable, on 6400 mil scale)
	0.1 or 0.01° (selectable on 360° scale)
SELECTABLE STORED	1:20 000, 1:24 000
MAP SCALES	1:25 000, 1:40 000

Status: Production. In service with unspecified countries.

FREE SELECTABLE SCALES

POWER SUPPLY

Manufacturer: Teldix GmbH, PO Box 105608, Grenzhöfer Weg 36, D-6900 Heidelberg 1, Federal Republic of Germany. Telephone: (06221) 512-300 Telex: 461735 Fax: (06221) 512-540

1:50 000, 1:100 000 1:200 000, 1:250 000 1:300 000, 1:400 000

1:10 000 to 1:500 000

24 ± 6 V DC vehicle supply

ISRAEL

Rafael RAFCOM-1 Heading Reference System

Development/Description

The Rafael RAFCOM-1 heading reference system is specifically designed for installation in heavy armoured vehicles such as MBTs, although the modular system design is such that it can be installed in a variety of vehicle types such as light vehicles.

The basic RAFCOM-1 configuration is:



Rafael RAFCOM-1 heading reference unit

- (a) antenna installed externally and which acts as the sensors unit
- (b) CPU installed internally and which performs the data processing and algorithm calculations
- (c) control and display unit with digital and analogue readings which can be installed in the crew compartment or in the turret.

The readings can be displayed on separate units for the driver and the commander or be integrated into an existing onboard fire-control system computer for display on a monitor.

The RAFCOM-1 reads magnetic North continuously without any intervention from the operator. Separate or integrated analogue or digital readings can be displayed either inside the crew compartment or near the vehicle commander's hatch. The system indicates magnetic North using special algorithms which compensate for the vehicle's own variable magnetic

These algorithms also compensate for dip or tilt inclination angles of up to ±20°, maintaining navigational accuracy in the moving vehicle.

SPECIFICATIONS (basic configuration)

DIMENSIONS

sensor unit antenna 140 mm diameter base × 1720 mm

CPU 130 × 165 × 300 mm control and display unit 145 × 125 × 85 mm

WEIGHT (total) 6.5 kg

ACCURACY tanks and other

armoured vehicles 3° (RMS) for all turret positions 2° (RMS) for turret ±15° to hull axis

light vehicles 1.5° (RMS)

COMPENSATION FOR INCLINATION ANGLES

up to ±20° dip and tilt angles

RESOLUTION 0.1° or 1 mil on digital display (four digits)

POWER SUPPLY

Status: Evaluation trials.

Manufacturer: Rafael, PO Box 2082, IL-31021 Haifa, Israel.

Telephone: (972) 4 776965 Fax: (972) 4 794657

TAMAM Land Navigation System – Mark I (LANS Mk I)

Description

The TAMAM LANS is a small lightweight inertial navigation system which is used to provide complete navigational facilities for both wheeled and tracked combat vehicles.

It consists of three main subsystems:

- 1) Heading Reference Unit (HRU), containing a two-gimbal inertial platform that provides, as the principle output, the vehicle's heading, associated electronics, a Distance Transmitter unit interface and an eightbit digital microprocessor which performs the gyrocompassing, navigation and automatic drift measurements and computations
- 2) Control and Display Unit (CDU) which employs a similar eight-bit microprocessor to transmit control panel information serially to the HRU and receive information back to be displayed on its screen
- 3) Distance Transmitter Unit (DTU), which is based on a photodiode technique.

System operating modes include: gyrocompass, navigation and autocalibration (using gyro drift measurement). Navigation is possible by use of co-ordinates, by bearing and distance, or with four different types of terrain compensation.

Any co-ordinate system, besides UTM (geographic), can be displayed and other optional facilities include a Remote Display Unit (RDU), integration with a laser rangefinder system, infra-red or moving map output. It is also possible to report position and azimuth data in real time via radio links to rear echelons

SPECIFICATIONS

irrespective of terrain HEADING ACCURACY 2 mrad

> 1 min (stored heading) 20 mins (full gyrocompassing)

TAMAM Land Navigation System Mk I

Status: Production (since 1981). In service with Israeli Defence Forces.

Manufacturer: Israel Aircraft Industries Ltd, Electronics Division, TAMAM Precision Instruments Industries, Yahud Industrial Zone, PO Box 75. IL-56100 Yahud, Israel.

Telephone: 972 3 5315003 Fax: 972 3 5315140



WEIGHT (total) 24 kg DIMENSIONS HRU 360 × 170 × 270 mm CDU 271 × 182 × 95 mm 67.2 mm diameter × 68 mm DTU POSITION ACCURACY 0.2% of total distance travelled WAYPOINTS STORAGE up to 50

10 mins (degraded accuracy) POWER SUPPLY 28 V DC 3.5 A vehicle supply



COLD START TIME

TAMAM Land Navigation System – Mark II (LANS Mk II)

Development/Description

The TAMAM LANS Mk II small, lightweight, all-weather, ECM-resistant, inertial, land navigation system is designed primarily for use on vehicles with artillery battalions (both towed and self-propelled), target location systems, battlefield surveillance, robotic systems, unmanned vehicles and special mobile attack units.

For the artillery, it eliminates the need for survey at the battery/battalion level thus providing a fast and accurate gun deployment and positioning capability in the engagement of time urgent targets.

The LANS Mk II comprises the following subsystems:

- (a) Attitude and Heading Reference Unit (AHRÚ) which contains a twogimbal platform providing the vehicle's headings, barometric pressure gauge for the unit's height, DTU interface and a microprocessor for executing the gyrocompassing navigation and automatic gyro drift measurements and computations
- (b) Control and Display Unit (CDU) which transmits control panel information serially to the AHRU and receives the data to be displayed on the panel. It also includes a communications line to the radio equipment
- (c) Distance Transmitter Unit (DTU) which transmits the distance covered by the vehicle to the AHRU and is based on a photodiode optoelectric element.

The modes of operation for the system are:

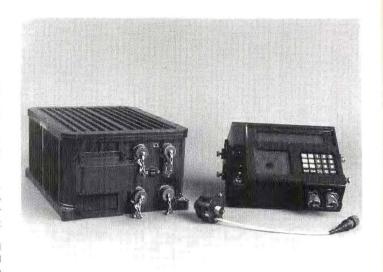
- (a) gyrocompassing
- (b) navigation
- (c) laying
- (d) autocalibration (including automatic gyro drift compensation)
- (e) test (using Built-In Test Equipment (BITE)).

These allow the LANS Mk II to:

- (a) navigate by co-ordinates, distance and azimuth
- (b) navigate by distance and azimuth to 20 waypoints
- (c) orientate (for gun laying)
- (d) terrain compensate by four different methods.

Optional features that can be supplied include:

- (a) display of any co-ordinate system in addition to UTM (that is geographic. AGR, GAUSS and KRUGGER)
- (b) integrate the system with other systems such as a laser rangefinder or infra-red device to enable target location to be determined
- (c) Driver Display Unit (DDU)
- (d) moving map display
- (e) general purpose serial output (for example for data transmission by radio).



TAMAM Land Navigation System Mk II

SPECIFICATIONS

 $\begin{array}{lll} \text{DIMENSIONS} \\ \text{AHRU} & 360 \times 170 \times 170 \text{ mm} \\ \text{CDU} & 271 \times 182 \times 95 \text{ mm} \\ \text{DTU} & 67.2 \text{ mm diameter} \times 68 \text{ mm} \\ \text{WEIGHT (total system)} & 25 \text{ kg} \end{array}$

POWER SUPPLY 28 V DC

POSITION ACCURACY 0.1-0.15% of total distance travelled (CEP)

ATTITUDE ACCURACY
AZIMUTH GYRO DRIFT
ALTITUDE ERROR
AZIMUTH ERROR
AZIMUTH ERROR
0.5 mrad (RMS)
0.3 mrad (RMS)
10 m (RMS)
1 mrad (RMS)

Status: In production. In service with the Israeli Army.

Manufacturer: Israel Aircraft Industries Ltd, Electronics Division, TAMAM Precision Instrument Industries, Yahud Industrial Zone, PO Box 75, IL-56100 Yahud, Israel.

Telephone: 972 3 5315003 Fax: 972 3 5315140

TAMAM Land Navigation System – Mark IV (LANS Mk IV)

Development/Description

The TAMAM LANS Mk IV small, lightweight, all-weather, ECM-resistant, inertial land navigation system, specifically designed for use in air defence vehicles and batteries, eliminates the need for survey at the battery/battalion level, thus providing a fast and accurate deployment and positioning capability in the engagement of time urgent targets by producing:

- (a) accurate common grid co-ordinates at the battery/battalion levels
- (b) fast and accurate azimuth/laying data
- (c) fast and accurate battery deployment and redeployments.

The LANS Mk IV comprises the following subsystems:

- (a) Attitude and Heading Reference Unit (AHRU) which contains a twogimbal platform that provides the vehicle heading, a barometric pressure gauge for the unit's height, DTU interface and a microprocessor for the gyrocompassing, navigation and automatic gyro drift measurements and computations
- (b) Control and Display Unit (CDU) which transmits control panel information serially to the AHRU and receives the data to be displayed on the panel. It also includes a communication line to the radio equipment
- (c) Distance Transmitter Unit (DTU) which transmits the distance covered by the vehicle to the AHRU and is based on a photodiode optoelectric element.

The modes of operation for the system are:

- (a) gyrocompassing
- (b) navigation
- (c) laying
- (d) autocalibration (including automatic drift compensation)
- (e) test (using Built-In Test Equipment (BITE).

These allow the LANS Mk IV to:

- (a) navigate by co-ordinates (UTM, AGR)
- (b) navigate by leg (distance and azimuth)
- (c) navigate by distance and azimuth to destination
- (d) orientate (for gun laying)
- (e) terrain compensate by four different methods.



TAMAM Land Navigation System Mk IV

Optional features include:

- (a) display of any co-ordinate system in addition to UTM and AGR
- (b) integration of the system with other systems such as a laser rangefinder or infra-red devices to enable target location to be determined
- (c) moving map display
- (d) general purpose serial output (for example for data transmission by

SPECIFICATIONS

DIMENSIONS

AHRU $360\times170\times270~\text{mm}$ CDU 271 × 182 × 95 mm DTU 67.2 mm diameter × 68 mm

WEIGHT (total) 25 kg POWER SUPPLY 28 V DC NAVIGATION ACCURACY 0.2% of distance travelled (CEP) HEADING ACCURACY ALTITUDE ACCURACY

ATTITUDE ACCURACY AZIMUTH GYRO DRIFT COLD START TIME

2.5 mrad (RMS) 10 m (RMS) 5 mrad (RMS) 0.4 mrad/h (RMS) 1 min stored heading

10 mins full gyrocompassing

Status: Production. In service with the Israeli Army.

Manufacturer: Israel Aircraft Industries Ltd, Electronics Division, TAMAM Precision Instrument Industries, Yahud Industrial Zone, PO Box 75.

IL-56100 Yahud, Israel

Telephone: 972 3 5315003 Fax: 972 3 5315140

TAMAM Vehicle Navigation System (VNAS)

Development/Description

The TAMAM VNAS is an independent, all-weather, ECM resistant, land navigation system for all types of wheeled and tracked armoured fighting vehicles. It provides self-alignment, North finding, continuous azimuth indication and distance measurement for accurate vehicle orientation

Position and heading data are displayed on a Control Display Unit (CDU) with alphanumeric and digital displays. The CDU also serves as the computer and control unit

Navigation can be performed by:

- a) waypoint setting by providing the azimuth and distance to chosen point(s) on the way to the required position which the vehicle will pass through
- b) self navigation by providing the location and azimuth of the vehicle and then setting its required position.

Navigation accuracy is terrain independent and is between 1-2% of the total distance travelled. Azimuth accuracy is 1°. Altitude measuring equipment is an optional extra.

The VNAS system comprises the following subsystems:

- (a) Control and Display Unit (CDU) which is a menu-driven navigation computer that has alphanumeric and digital displays
- Directional Gyro Indicator (DGI) which maintains the vehicle direction with low azimuth drifts
- (c) Distance Transmitting Unit (DTU) which converts wheel rotation to electrical impulses using an optical encoder
- (d) North Reference Unit (NRU) which measures the horizontal and vertical components of the earth's magnetic field by a flux gate magnetic

The VNAS performs dead reckoning navigation by measuring distance travelled and azimuth. Distance measurement is performed by means of counting DTU pulses. Azimuth to North is measured by NRU/DGI

Initial azimuth to North is set through a North finding process which calibrates the DGI as an accurate heading reference. The calibrated NRU provides an initial azimuth accuracy of 0.5 (RMS).

The VNAS also enables the use of alternative inputs for initial azimuth:

- (a) NRU, immediate data azimuth setting
- (b) external source and manually input
- (c) stored heading azimuth.

In the navigation mode the VNAS incorporates special software procedures for maintaining azimuth by the DGI and eliminating possible long term DGI drifts by hybridisation with the NRU.

Options include:

- (a) integration with Global Positioning System (GPS) as a dual back-up system and for synergies correction of navigation errors
- (b) integrated compass version for vehicle azimuth indication this comprises the DGI, NRU and a Driver Display Unit (DDU).

SPECIFICATIONS

DIMENSIONS

CDU 270 × 180 × 95 mm DGI 160 × 160 × 160 mm DTU 70 mm diameter × 70 mm NRU 60 mm diameter × 70 mm

WEIGHT (total) 8 kg

NAVIGATION ACCURACY 0.5-1% of distance travelled (CEP) AZIMUTH ACCURACY 0.5-1% (RMS) using North finding process

WAYPOINTS STORAGE up to 100 COLD START TIME (max) 3 mins NORTH FINDING TIME 2 mins

ELECTRICAL INTERFACE RS232/RS422 communication serial port POWER SUPPLY

28 V DC

Status: In production. In service with the Israeli army.

Manufacturer: Israel Aircraft Industries Ltd, Electronics Division, TAMAM Precision Instruments Industries, Yahud Industrial Zone, PO Box 75, IL-56100 Yahud, Israel

Telephone: 972 3 5315003 Fax: 972 3 5315140



TAMAM Vehicle Navigation System (VNAS)

TAMAM Guns Orientation and Navigation System (GONS)

Development/Description

The TAMAM GONS is a small, lightweight, inertial gun positioning and aiming system for self-propelled artillery and rocket launchers. It eliminates the need for survey at the battery/battalion levels and provides the selfpropelled unit with continuous and accurate elevation and azimuth data. together with a determination of the gun/launcher location relative to ground co-ordinates

It can also report the gun position, azimuth and laying data in real time through an existing radio channel to a higher echelon or command post.

The main GONS components are:

- (a) Attitude and Heading Reference Unit (AHRU)
- (b) Control and Display Unit (CDU)

- (c) Gunner Display Unit (GDU optional)
- (d) Distance Transmitter Unit (DTU optional)
- (e) Elevation Measuring Unit (EMU).

The system provides the following functions:

- (a) laying it displays the gun azimuth and elevation
- (b) navigation it updates its location automatically and enables two modes of navigation to be employed: self and by waypoints
- (c) calibration it calibrates distance, barrel azimuth, barrel elevation and the system itself
- (d) gyrocompassing it performs either self-gyrocompassing or external azimuth through keyboard or serial communication
- (e) test using Built-In Test Equipment (BITE)).



TAMAM Guns Orientation and Navigation System (GONS)

SPECIFICATIONS

 DIMENSIONS

 AHRU
 375 × 270 × 170 mm

 CDU
 271 × 182 × 95 mm

 EMU
 154 mm diameter × 75 mm

 DTO
 67 mm diameter × 67 mm

WEIGHTS
AHRU 18 kg
CDU 3.8 kg
EMU 3 kg
DTU 0.2 kg

POSITION ACCURACY 0.1-0.15% of total distance travelled

(CEP)

ATTITUDE ACCURACY
GUN AZIMUTH ACCURACY
AZIMUTH GYRO DRIFT
GUN ELEVATION ACCURACY
ALTITUDE ERROR
0.5 mrad (RMS)
0.3 mrad (RMS)
0.5 mrad (RMS)
0.5 mrad (RMS)

Status: In production. In service with the Israeli Army.

Manufacturer: Israel Aircraft Industries Ltd, Electronics Division, TAMAM Precision Instruments Industries, Yahud Industrial Zone, PO Box 75, IL-56100 Yahud, Israel.

Telephone: 972 3 5315003 Fax: 972 3 5315140

TAMAM Directional Gyro Indicator (DGI)

Description

The TAMAM DGI is an inertial land navigation device providing heading capability for tanks, jeeps, armoured and other wheeled or tracked vehicles.

After a simple initial azimuth adjustment the DGI maintains accurate heading information for several hours. The DGI North-setting modes available include:

- (a) using a gyro or magnetic compass
- (b) directing the vehicle towards a known target and setting the heading
- (c) 'runway alignment' riding along a familiar road and setting the heading accordingly
- (d) data communication by using information supplied by other vehicles equipped with an accurate land navigation system.

The heading is displayed on a clear 360° scale with a special indicator for vehicle direction. Accuracy is 1°/h for up to a four hour journey.

Options include:

(a) a digital resettable distance meter

- (b) additional display unit
- (c) azimuth synchro output
- (d) optical sight for observation and tracking.

SPECIFICATIONS

DIMENSIONS $160 \times 160 \times 160 \text{ mm}$

WEIGHT 3 kg

POWER SUPPLY 24 V DC vehicle (or 115/26 V AC, 400 Hz

optional)

Status: In production. In service with the Israeli Army.

Manufacturer: Israel Aircraft Industries Ltd, Electronics Division, TAMAM Precision Instruments Industries, Yahud Industrial Zone, PO Box 75, IL-56100 Yahud, Israel.

Telephone: 972 3 5315003 Fax: 972 3 5315140

TAMAM North Finding Module (NFM)

Development/Description

The TAMAM NFM is a lightweight, portable, inertial navigation system that is designed to provide autonomous and accurate North finding and azimuth data for artillery alignment (as used by the Israeli Army) and rapid emplacement of mobile radars/DF antenna and missile radars/launchers.

The NFM is not affected by iron parts or magnetic fields, and can perform accurately in the presence of host vehicle base motion caused by soil settling, wind buffeting or personnel movement.

SPECIFICATIONS

 WEIGHT
 3.4 kg

 ACCURACY
 1-2 mils

 REACTION TIME
 2-2.5 mins

ALLOWABLE INCLINATION ±5.6° (may be extended)

OPERATING LATITUDE 70° (can be operated at a higher latitude with

reduced accuracy)

SERIAL COMMUNICATIONS RS232/RS422

Status: Production. In service with Israeli Army.

Manufacturer: Israel Aircraft Industries Ltd, Electronics Division, TAMAM Precision Instruments Industries, Yahud Industrial Zone, PO Box 75, IL-56100 Yahud, Israel.

Telephone: 972 3 5315003 Fax: 972 3 5315140



TAMAM North Finding Module (NFM)

SOUTH AFRICA

Barcom ANV 90 Integrated Vehicle Navigation System

Development/Description

The ANV 90 is a vehicle-mounted navigation system for use on tracked and wheeled vehicles. The ANV 90 incorporates primary information from its integrated ANM 90 GPS unit into information obtained from various Dead Reckoning (DR) sensors. This integrated approach allows for full navigation during periods when the GPS satellites links are being jammed or when they are screened by terrain, building and so on. The ANV 90 will automatically revert to the DR mode when appropriate satellite information is unavailable.

DR navigation is possible when heading and distance (or speed) information is available. The ANV 90 accepts:

 (a) heading data from either a suitable gyro-compass (for improved accuracy at a higher cost) or a magnetic compass (lower accuracy at a lower cost)

(b) distance information from a distance transmission unit coupled to the vehicle's transmission system.

Whilst GPS satellites are being tracked the ANV 90 also automatically calibrates the DR sensors on a continual basis so as to improve the accuracy in the DR mode.

Appropriate steering information is displayed to the driver on a driver display unit. The information is available as left/right steering instructions, vehicle heading and distance to go to selected waypoints.

The GPS antenna is mounted externally on the vehicle and is protected by a heavy duty radome. The integrated GPS is basically Barcom's ANM 90 manpack navigation system which provides precise three dimensional position, velocity and time data by using parallel tracking channels and a Kalman filter.

SPECIFICATIONS

DIMENSIONS

antenna 180 mm long x 181 mm diameter

VAU 186 × 178 × 221 mm
RPU 67 × 176 × 180 mm
CDU (also ACDU) 40 × 100 × 200 mm
DDU 75 × 45 × 135 mm
Gyro (HRU) 165 × 165 × 200 mm
MCU 90 × 140 mm

WEIGHTS antenna 1.1 kg VAU 4.8 kg RPU 2.3 kg CDU (also ACDU) 0.7 kg DDU 0.7 kg Gyro (HRU) 4.5 kg MCU 0.9 kg POWER SUPPLY 10 to 32 V DC PERFORMANCE WITH GPS time-to-first-fix < 2 min GPS POSITION UPDATE RATE 2 s intervals

ACCURACY RMS, selective availability not applied.
HDOP<1.5 and 4 satellites

tracked

absolute differential 15 m 5 m altitude 24 m 7 m velocity 0.3 m/s 0.3 m/s time < 1 µsec < 1 µsec

CALIBRATION
heading reference to within 0.5°
distance sensor to within 0.5%

DEAD RECKONING

along track error < 1% of the distance travelled since last known

accurate position and provided no change in motion sensor calibration

cross track error < 1.5% of distance travelled per hour of time elapsed since last motion sensor calibration

Status: Production as required. In service with South African Defence Force.

Manufacturer: Barcom Elecronics (Pty) Ltd, PO Box 15271, Verwoerdburgm

0140, Republic of South Africa.

Telephone: 27 12 660 0632 Fax: 27 12 660 0636

UNITED KINGDOM

GEC-Ferranti FIN 1155 Land Navigation and Attitude Reference System

Development

The FIN 1155 is a small, lightweight, inertial navigation system designed for use in land vehicles such as tanks, APCs, self-propelled mortar vehicles and towed artillery systems. It provides outputs of position and attitude in pitch, roll and azimuth thus producing data suitable for navigation, steering and sight attitude.

The system is based on a two-gimballed inertial platform specifically designed to give inertial quality performance from a less complex semi-strapdown configuration. Extensive trials have taken place in the UK and overseas on the Chieftain and Challenger 2 MBTs as well as other vehicles.

The technology is derived from the Position and Azimuth Determining System (PADS) design described in a following entry.

Description

The FIN 1155 comprises, along with the interconnecting cable set, the following LRUs:

- (a) the Inertial Measuring Unit (IMU) which contains the inertial platform, electronics, power supply modules and Vehicle Interface Plate (VIP)
- (b) the Odometer Transducer Unit (OTU) which aids the system by providing velocity information that is combined with data from the IMU via a Kalman filter.

The input/output information is sent by a serial data link to either an operator's control/display panel or other systems such as fire-control or ballistic computers. Continuous outputs of position, azimuth and attitude are available for navigation and steering, as well as velocity and attitude rates for gun aiming and stabilisation. The installation plate is pre-adjusted to the vehicle's reference axes to facilitate the fitting, and exchange if necessary, of the IMU.

The operation of the FIN 1155 is as follows: after initial system start-up the system automatically enters the alignment mode; at the completion of this mode the following outputs are available:

- (a) grid position to 1 m resolution
- (b) latitude and longitude to 1 arc second resolution

- (c) orientation in azimuth, roll, pitch or elevation
- (d) grid convergence angle.

Once configured and initiated alignment time is reduced allowing quick vehicle reaction time using stored heading or entered azimuth.

The system can also gyrocompass in both stationary and moving vehicles. This dynamic alignment capability tolerates vehicle motion during 'static' gyrocompassing and also enables the inertial platform to level whilst the vehicle is manoeuvring.

Advantage can be taken of any unplanned vehicle stops that occur as the system will accept position update information at any time. Provision has also been made for the entry of position co-ordinates in advance to allow updating at known waypoints to be rapidly executed.

The FIN 1155 will accept and output data in either grid or geographic format. A large number of grids/spheroids used throughout the world can be provided within the system. A comprehensive data bank of positional information on known points is also available to enhance the effectiveness of the operational range.

Integration with GPS will employ one of the following options:

- (a) An embedded GPS receiver fully integrated with the system's Kalman filter
- (b) Employing the GPS information from an existing onboard receiver.

SPECIFICATIONS

WEIGHT

IMU 18 kg

VIP 3 kg

OTU 0.7 kg

DIMENSIONS

 IMU
 265 × 260 × 460 mm

 VIP
 265 × 55 × 460 mm

 OTU
 105 × 65 × 100 mm

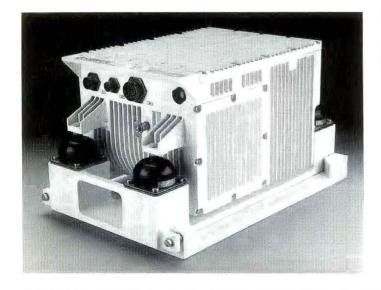
 POWER SUPPLY
 24 V DC

 OPERATIONAL RANGE
 70°N to 70°S

POSITION ACCURACY AZIMUTH ACCURACY

AFTER ALIGNMENT 10 mils RMS (performance improves when in 'navigate' mode)

1% of distance travelled RMS



Status: Ready for production.

Manufacturer: GEC-Ferranti Defence Systems Ltd, Navigation and Electrooptics Systems Division, Silverknowes, Ferry Road, Edinburgh EH4 4AD, Scotland.

Telephone: (031) 332 2411 Telex: 727101 Fax: (031) 343 5050

GEC-Ferranti FIN 1155 Inertial Measuring Unit (IMU)

GEC-Ferranti FIN 5500 Land Navigation and Attitude Reference System

Development

The FIN 5500 is a small ring laser gyroscope inertial navigation system designed for towed and self-propelled artillery, battery positioning and reconnaissance vehicle applications. It provides accurate position and attitude information in pitch, roll and azimuth and rate information for sight and barrel positioning in three dimensions.

The system is based on the GEC-Ferranti designed embedded ring laser gyroscope cluster containing three ring laser gyroscopes in a compact module. The design and development philosophy was to provide a single module for integration with various electronic units for specific applications, the advantages offered being a reduced size, weight and reduction in the components and construction.

Description

The FIN 5500 consists of the following LRU's:

- (a) Inertial Measuring Unit (IMU) which contains the embedded ring laser gyroscope cluster, associated electronics, power supply and interface plate
- (b) Odometer Transmitter Unit (OTU) which provides velocity aiding information for assessment in the Kalman filter together with inertial information from the IMU
- (c) optional Control and Display Unit (CDU) for use when the system is not integrated into the onboard fire-control system.

The FIN 5500 is a completely autonomous navigation system which required no external reference. It provides position, direction and attitude continuously under all operating conditions. The system is free from the effects of jamming and requires only an initial position to initiate the system. It provides the full position and pointing accuracy typically required for artillery survey, gun-laying and navigation for self-propelled guns and artillery observer vehicles.

A stored heading allows the system to operate within 30 seconds and provide the necessary information for a rapid move. The system can be provided with a number of types of start position in order to provide tactical flexibility. The FIN 5500 may also be integrated with an external and embedded Global Positioning System (GPS) receiver. Such integration allows initial position to be determined automatically. It also provides a further source of velocity information and improves the reaction time and mission time in certain scenarios.

Although not required to provide full system performance, zero velocity updates may be used in the reversionary mode to provide a navigation capability in the event of an OTU failure.

The system employs a Kalman filter, a mathematical model which assesses a number of signals or inputs enabling the vehicle's track slip and steering slip to be compensated for and not effect the overall system accuracy. The filter also enables the system to be fitted to a number of types of wheeled and tracked vehicles allowing automatic compensation to be carried out for differing tracks and wheels.

The system automatically carries out position and alignment updating by using both planned and unplanned vehicle stops. There is also the facility to store up to 100 waypoints, survey and mark positions into the system for use in route and deployment planning.

SPECIFICATIONS

WEIGHTS	
IMU	18 kg
VIP	3 kg
OTU	0.7 kg
DIMENSIONS	

 $\begin{array}{lll} \text{IMU} & 320 \times 176 \times 206 \text{ mm} \\ \text{VIP} & 320 \times 55 \times 206 \text{ mm} \\ \text{OTU} & 105 \times 65 \times 100 \text{ mm} \end{array}$

POSITION ACCURACY 10 m PE for distance travelled up to

4000 m

0.25% CEP for distance travelled

greater than 4000 m 1 mil RMS noraml

AZIMUTH ACCURACY 1 mil RMS noraml 0.5 mil RMS extended

PITCH AND ROLL ACCURACY 0.5 mil RMS LATITUDE OPERATING RANGE 65°N to 65°S POWER SUPPLY 24 V DC

Status: Ready for production.

Manufacturer: GEC-Ferranti Defence Systems Ltd, Navigation and Electro-optics Systems Division, Silverknowes, Ferry Road, Edinburgh, EH 4AD. Scotland.

Telephone: 031 332 2411 Telex: 727101 Fax: 031 343 5050

GEC-Ferranti Positioning and Azimuth Determining System (PADS) Mk 2

Developmen

The original PADS Mk 1 was designed and built to meet a Royal Artillery requirement for a fast, compact and self-contained survey system. The current PADS Mk 2 model combines the original concept with newer technology derived from the FILS commercial equivalent. The Mk 2 is suitable for a wider range of missions including position and orientation data for guns, missile and rocket launchers, observation posts and surveillance devices, together with improved navigation facilities and onboard processing.

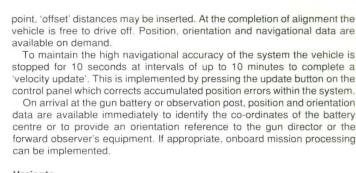
Description

The system comprises a rugged box containing the Inertial Measuring Unit (IMU), electronics and power supplies; there is a separate control/display unit which can be located at any convenient position in the vehicle. These items, along with the mounting tray, weigh 51 kg overall.

The performance of the system can be extended by adding a transfer battery box to enable the system to be transferred live between vehicles or from vehicle to helicopter whilst continuing the survey. It can be further extended by providing data logging, hard copy output of a mission's processed results and the integration of an Electronic Distance Measurer (EDM) for long offset measurement.

Position data is output in geographical or UTM grid co-ordinates to a resolution of 0.001 arc seconds or 0.01 m, height to 0.01 m, resolution and azimuth in terms of both true and grid North to a resolution of 10 arc seconds or 0.01 mil. Azimuth is transferred to an external equipment such as an artillery director, theodolite or laser rangefinder by autocollimation or by fixing two bearing pickets.

The PADS Mk 2 can store up to 62 waypoints in any combination of known co-ordinate values or new stations fixed by the system. Whenever



GEC-Ferranti Position and Azimuth Determining System (PADS) Mk 2 installed in the rear of a Land Rover

position or azimuth update information becomes available from external sources the system permits all current traverse data to be reprocessed (onboard mission processing). This provides greater precision and enhances the accuracy of subsequent real-time observations

External update information may be supplied in the form of:

- (a) known co-ordinates for a position being surveyed
- (b) the known azimuth or the system's alignment
- (c) re-surveying of a point previously included in the traverse
- (d) a series of velocity updates at the same point.

The system has an operational latitude capability between 75° North and 75° South, and within the temperature range -32°C to +50°C

The PADS Mk 2 can be operational within five minutes of switch-on. Accurate initial position information (obtained at a survey point) is inserted via the control panel together with the approximate orientation data from a magnetic compass. This is followed by an automatic alignment process within PADS to align the inertial instruments to North and East. As it is not always possible to position the vehicle precisely over the required survey

point, 'offset' distances may be inserted. At the completion of alignment the vehicle is free to drive off. Position, orientation and navigational data are

To maintain the high navigational accuracy of the system the vehicle is stopped for 10 seconds at intervals of up to 10 minutes to complete a 'velocity update'. This is implemented by pressing the update button on the

On arrival at the gun battery or observation post, position and orientation data are available immediately to identify the co-ordinates of the battery centre or to provide an orientation reference to the gun director or the forward observer's equipment. If appropriate, onboard mission processing

Variants

PADS Mk 2 can undertake a wide range of other military applications, such as helping to fill in details or update military survey maps, establish the location of minefields during mine-laying operations and, in remote areas, provide survey and topographical profiles for mapping and communications networks. Airborne PADS Mk 2 fitted to a helicopter may be used for target location as well as gunner survey with the same accuracy as land-based versions.

SPECIFICATIONS

540 × 470 × 300 mm DIMENSIONS

WEIGHT 51 kg 24 to 28 V DC POWER SUPPLIES

25 or 60 A for warm up, 10 A normal

ACCURACY (after onboard processing)

For short traverse up to 15 km:

Relative accuracy between adjacent points 1 km apart: 1 m CEP

For missions of 3 hours or 75 km: horizontal 3 m CEP vertical 0.5 m CEP

Orientation 1.3 mil PE

Status: In production. In service with India, UK and other undisclosed countries.

Manufacturer: GEC-Ferranti Defence Systems Ltd, Navigation and Electrooptics Systems Division, Silverknowes, Ferry Road, Edinburgh EH4 4AD. Scotland

Telephone: (031) 332 2411 Telex: 727101 Fax: (031) 343 5050

GEC Avionics Azimuth Position and Elevation System (APES)

Development/Description

The APES is a ring laser gyro navigation system which is now in production by GEC Avionics for the Warrior Mechanised Artillery Observation Vehicle to meet the requirements of the Royal Artillery.

Ring laser gyros in a strapdown configuration, due to their instant start and lack of moving parts, ensure fast reaction and high reliability, which leads to a reduction in maintenance and through-life cost.

APES is based on a Honeywell Inc Dynamic Reference Unit (DRU) and a GEC Avionics Control and Display Unit (CDU) and is interfaced with a laser rangefinder. This combination provides a means of calculating extremely accurately the grid co-ordinates and altitude of a target, having determined its grid bearing, elevation angle and distance.

The CDU provides the operator interface and displays a clear and unambiguous readout of the vehicle position, waypoint and its bearing and range from the vehicle position. It also displays time and trip distance and, in the surveillance mode, altitude, turret bearing and elevation, and target position.

In September 1987 GEC Avionics Guidance Systems Division was awarded a contract worth (with options) over £17 million by the UK Ministry of Defence to supply APES units to GKN Defence for integration into the Warrior Artillery Observation Post Vehicle.

SPECIFICATIONS

AZIMUTH ELEVATION 0.5 mil

POSITION 0.25% distance covered REACTION TIME less than 15 mins

Status: In production. In service with British Army.

Manufacturer: GEC Avionics Limited, Guidance Systems Division, Airport

Works, Rochester, Kent ME1 2XX, UK

Telephone: (0634) 844400 Telex: 96333 Fax: (0634) 816748



Main components of the GEC Avionics Azimuth Position and Elevation System (APES) showing DRU with CDU on top

GEC Avionics Land Navigation System (LNS)

Development/Description

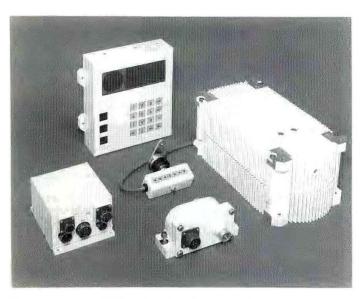
The GEC Avionics Land Navigation System (LNS) is a self-contained, totally autonomous, strapdown, inertial technology system, allowing gyrocompass setting without any pre-orientation of the vehicle.

It has been tested on a number of vehicles worldwide, including Challenger 1, M1A1, M48, Type 59, Warrior, Scorpion, M113 and Land Rover.

The vehicle velocity, derived from an odometer/Doppler speed sensor, is resolved about the heading angle to provide navigation. The system has been designed for use in the full range of military vehicles, both wheeled and tracked. Different speed sensors and scale factors are accommodated by use of a suitable patch plug contained in the vehicle wiring. This enables LNS to be directly interchangeable between vehicles of different types, as needed.

The system comprises a Navigation Control Unit, a Navigation Interface Unit, an Odometer Transducer Unit, a Remote Driver's Indicator and an Inertial Measuring Unit.

In its simplest operating mode all the operator has to do is switch it on and insert his own grid position using the Navigation Control Unit keyboard.



Main components of GEC Avionics Land Navigation System from left to right: Navigation Interface Unit, Navigation Control Unit, Remote Driver's Indicator (optional), Odometer Transducer Unit and Inertial Measuring Unit

The system determines the vehicle's heading with respect to true North by measuring components of the Earth's rotation rate whilst the vehicle is stationary during the "align" mode. A correction is automatically added to the heading when the present position UTM (geographic) co-ordinates are inserted to give a grid heading. After this alignment the system automatically enters the "navigate" mode which is its normal operation mode.

If a quick start-up is required the stored heading alignment mode can be selected, which enables the vehicle to move 30 seconds after switch-on.

The equipment has provision to store the co-ordinates of up to nine different positions and retain them when the equipment is switched off. By selecting any of these positions as the destination, the system provides the driver with steering information to enable him to drive to that position. In addition, the commander is provided with a continuous update of range and bearing to that destination, as well as a continuous update of his own position as the manoeuvre progresses. A compass rose presentation of vehicle heading is provided for the commander, enabling him to orientate his maps quickly.

A "fix" feature is also provided which allows the displayed present position to be updated as map referenced features are reached.

SPECIFICATIONS

1.5% CEP (of distance travelled during POSITION ACCURACY 2 h mission with no updates) POWER SUPPLY vehicle system INITIAL GYROCOMPASS SETTING TIME 5 mins REFRESH GYROCOMPASS SETTING TIME 2 mins STORED HEADING ALIGNMENT TEMPERATURE RANGE 40° to +55°C POWER CONSUMPTION 35 W 2000 h WEIGHT OF IMU 6.8 kg WEIGHT OF NCU 3.6 kg WEIGHT OF NIFU 0.9 kg WEIGHT OF OTU 0.45 kg SIZE OF IMU 305 × 152 × 127 mm SIZE OF NCU 158 × 51 × 203 mm SIZE OF NIFU 127 × 102 × 76 mm SIZE OF OTU 127 × 51 × 51 mm

Status: Ready for production.

Manufacturer: GEC Avionics Limited, Guidance Systems Division, Airport

Works, Rochester, Kent ME1 2XX, UK. Telephone: (0634) 844400 Telex: 96333 Fax: (0634) 816748

UNITED STATES OF AMERICA

KVH MV103 Series Digital Fluxgate Compasses

Development/Description

The MV family of digital compass systems was developed to address the needs of the US military for a rugged militarised electronic compass to provide accurate and reliable heading information in military applications where conventional card compasses could not, and gyros were too expensive

All of the MV103 series compasses use solid-state fluxgate sensor technology to determine the heading of the sensor relative to local magnetic North, thereby eliminating the problems of swim, swirl and overshoot which are commonly found with traditional compasses and make them difficult to read. The MV family also incorporates methods that accurately cancel out the effects of magnetism associated with the host platform and make use of microprocessor-based signal processing.

The MV family models currently available are:

MV103A - the US Marine Corps tested the MV103A for two years before selecting the unit for their AAV7A1 Amphibious Assault Vehicles. This model provides continuous, accurate heading data throughout a wide range of climatic weather regimes, including cold weather operations in northern Norway. In 1988 the US Marine Corps ordered 1500 MV103A compasses, with all being delivered by February 1989.

MV103B - this is a general-use variant for application in a wider area of military uses. It has $\pm 1^{\circ}$ accuracy with 1 mil resolution. It provides three levels of damping, a set course mode, a display light and an RS232 port for interfacing (cable provided) with other systems. The MV103B is provided complete with a remote sensor, 7.62 m of cable, a heading display with 1.524 m of cable, and a junction box with cable connectors, compensation potentiometers, controls for power, light, damping level, and an off-course mode. An EMI/RFI-shielded spare fuse holder and fuse are fitted as

MV103C - this is the MV103 variant for use with light armoured vehicles. It displays the magnetic heading in either degrees or mils, provides both normal and reciprocal headings, has eight levels of damping and allows the operator to manually input declination.

The system has a $\pm 1^{\circ}$ accuracy with 1 mil resolution. An RS232 interface port is standard (cabling is optional). It comes complete with: remote sensor; 7.62 m of sensor cabling; two heading indicators each with 1.524 m of cable; a 4.572 m power cable; a junction box with cable connectors, compensation potentiometers and option controls for - power/light, degrees/ mils and normal/reciprocal heading; a function switch for displaying and



Main components of the KVH MV103A Digital Fluxgate Compass system

setting; a damping level control; an off-course mode switch; and declination input. An EMI/RFI-shielded fuse holder, fuse and spare are fitted as standard.

MV103AC - The MV103AC is a prototype Global Positioning Satellite (GPS) compatible system for use on heavy armoured vehicles. Developed under contract for the US Army, the MV103AC has a unique microprocessor controlled self-compensation capability which allows the compass to overcome platform magnetic interference through a single turn of the vehicle. In December 1990 a variant of the MV103AC was delivered to the US Marine Corps for use on the AAV7.

MV103BT - This is the next generation of GPS compatible system, the MV103BT, for use on MBTs.

Status: MV103A in production. In service with the US Marine Corps (AAV7A1)

MV103B in production. In service with the US Navy (on all Landing Craft types)

MV103C evaluation trials with various military groups.

MV103AC evaluation trials with US Army and US Marine Corps. MV103BT final development.

In February 1991 KVH was awarded a \$1.6 million contract to equip US Marine Corps LAV-25 light armoured vehicles with a fluxgate compass.

Manufacturer: KVH Industries Inc, 110 Enterprise Center, Middletown, Rhode Island 02840, USA.

Telephone: (401) 847-3327 Telex: 382051 Fax: (401) 849-0045

Collins Trooper™ Handheld/Vehicular GPS Receiver

Development/Description

The Trooper™ GPS receiver is based on the Rockwell NavCore® V GPS engine, with five parallel L1 C/A code channels and a time-to-first-fix of typically less than 30 seconds. It can store up to 100 user-defined waypoints and 10 user-defined routes with full waypoint/route editing capabilities. The handheld unit can also be mounted in a vehicle to use vehicle power and antenna in less than one minute.

The digital unit displays steering and track history information, Speed Over Ground (SOG), Course Over Ground (COG), Time To Go (TTG), Velocity Made Good/ground speed (VMG), Estimated Time of Arrival (ETA) and CrossTrack Error (XTE). The five soft keys are labelled by the graphic display to indicate the menu of available operations on each screen.

The night-vision goggle compatible, sunlight readable, 128×128 pixel display graphically shows the waypoints, position, routes, track/steering data and other navigation information. The information is provided in latitude, longitude, altitude, Military Grid Reference System (MGRS) and Universal Transverse Mercator (UTM). The altitude is referenced to 52 selectable map datums including WGS-84 and to user defined.

The Trooper also includes both RS232 and infra-red optical interfaces to transfer waypoint and route data base information between Trooper units

or between a Trooper and an external computer data base management system. A Built-in Test facility is also fitted.

SPECIFICATIONS

less than 0.91 kg DIMENSIONS 88.9 × 190.5 × 68.6 mm POWER SUPPLY

9 to 28 V DC (from 5 w source) external 9 to 40 V DC vehicular system

6 x type AA standard battery pack or 6 x internal type C alkaline/NiCad battery pack

(BA5800 lithium pack type optional)

POSITION ACCURACY <25 m CFP

VELOCITY ACCURACY 0.1 m/s RMS steady state DYNAMICS velocity 0-300 m/s

acceleration 2 g

Status: Production as required.

Manufacturer: Rockwell International, Collins Avionics & Communications Division, 350 Collins Road NE, Cedar Rapids, Iowa 52498, USA.

Telephone: (319) 395-5100

Collins Mission Planning Station for TrooperTM Handheld/Vehicular GPS Receiver

Development/Description

The Mission Planning Station for the Trooper™ GPS receiver is based on the 25 MHz 486DX Toshiba T4400SXC VGA laptop computer. Through a user friendly Microsoft Windows® software package it permits the user to create and maintain libraries of waypoints and routes that can be transferred directly to the Trooper receiver. Waypoints developed and stored in a Trooper can also be transferred to the Mission Planning Station and added to the library

With a CD ROM map data base, the Mission Planning station allows users to create any number of waypoints or routes using a mouse driven cursor to select points from a map displayed on the screen. Waypoints and routes in the data base can also be plotted on the map display for easy verification, mission briefing or debriefing.

A built-in waypoint calculator lets the operator easily convert between various co-ordinate systems, including latitude/longitude, Military Grid Reference System (MGRS), Universal Transverse Mercator (UTM) and Earth Centered Earth Fixed (ECEF). Altitude can be referenced to 52 userselectable datums including WGS-84.

The system also feaures SatView, a satellite visibility program that identifies which GPS satellites are usable for navigation at any given time. A Trooper monitor feature permits the user to remotely monitor the handheld receiver and control its functions from the laptop computer.

SPECIFICATIONS

WEIGHT 3.3 kg DIMENSIONS 297.2 × 210.8 × 55.9 mm MICROPROCESSOR 25 MHz 486 DX 8 K cache DISPLAY LCD with VGA resolution MEMORY

4 Mbytes 120 Mbytes HARD DISK FLOPPY DISK DRIVES 1.44 Mbytes 3.5 in

COMPUTER CONFIGURATION portable 486 laptop with mouse, modem, CD-ROM drive and digital map data bases

Status: Production as required.

Manufacturer: Rockwell International, Collins Avionics & Communications Division, 350 Collins Road NE, Cedar Rapids, Iowa 52498, USA. Telephone: (319) 395-5100

Bendix Stabilisation Reference Package/Position Determining System (SRP/PDS)

Development/Description

The SRP/PDS was designed for use with the MLRS programme M270 Armoured Vehicle-Mounted Rocket Launcher (AVMRL) and is enclosed within a two-compartment housing which is hard mounted to the launcher loader. One compartment contains the seven electronics modules which include all the servo electronics, power supply and the microprocessor. The complete list of electronic subsystem cards is:

- (a) gyro buffer level buffer bridge
- (b) regulator and EMI filter
- (c) R/D, converter
- (d) servo electronics
- (e) azimuth and drive electronics
- (f) 9090 microprocessor/interface and 4 Kbyte Read Only Memory (ROM) with 256 bytes of scratchpad memory (RAM). The timing sequence required is accomplished through the software by the real-time clock interruption

- (g) gyro excitation and power supply
- (h) compensation electronics.

The other compartment contains the gimbal assembly which includes the following subsystems:

- (a) two small LG-60 gyros utilised for gimbal stabilisation with single degreeof-freedom liquid hydrostatic float suspension. The gyro motors are 12 000 rpm, ball bearing, synchronous, with an overall system angular momentum of 30 x 103 gm cm2/s. The mode of operation is by output axis vertical rate
- (b) two electrolytic, thermally isolated level sensor assemblies utilised for levelling during gyrocompass-setting and maintaining level during the directional gyro mode. The linear range is $\pm 4^{\circ}$ with a scale factor of 6.4 s/mv and stability of 0.004 s/s
- (c) one SDF LG-800 high performance North-seeking gyro utilised as a rate sensor during gyrocompass-setting and also in a dual role as the directional gyro. It is of the liquid hydrostatic suspension type with a single degree-of-freedom. The gyro motor is ball bearing synchronous at 12 000 rpm, with an angular momentum of 400 x 103 gm cm2/s. The modes of operation are output axis vertical for gyrocompass-setting and output axis horizontal for dynamic reading

The gyrocompassing technique involves the gyrocompass rate sensor finding North by measuring the horizontal component of the Earth's rotation rate. The sensor is mounted with its sensitive axis or input axis in the plane of a stabilised table. The platform table is maintained level by use of a levelling servo-loop which utilises the two electrolytic nulling level sensors. Whilst it is operating the North-seeking LG-800 unit is also isolated from any elevation and roll motion or environmental disturbances by the two LG-60 stabilisation gyros.

The SRP/PDS provides the following functions to the M270 AVMRL:

- (a) input and feedback signals to the launcher servo control system
- (b) establishes launcher azimuth heading from true North
- (c) establishes launcher elevation angle from the horizontal plane
- (d) maintains heading information during AVMRL movements
- (e) aims the rocket modules
- (f) stabilises the launcher before, during and following ripple or single round rocket firings
- (g) retargets the launcher assembly automatically
- (h) an accurate PDS capability. When utilising this mode the SRP/PDS provides three-dimensional land navigation data in UTM grid co-ordinate format to an accuracy of 0.25% of the distance travelled in all axes.

Upon reaching a known survey point the unit will automatically update and calculate the cause for any error and correct. When stationary the PDS mode will measure DG drift and update to zero drift. Design speed range is up to 100 km/h.

Variants

An Improved Stabilisation Reference Package (ISRP) is used in the Army

Tactical Missile System (ATACMS) programme which utilises the M270 AVMRI

SPECIFICATIONS

WEIGHT 29 kg
DIMENSIONS 254 x

 DIMENSIONS
 254 x 604 x 272 mm

 ELEVATION ANGLE
 +60°, −30°

 ROLL ANGLE
 ±30°

 AZIMI ITH
 360°

MOUNTING 3 point/30 s (no isolators required)

ANGULAR RATE ACCELERATION

azimuth ±200°/s, 6000°/s²
elevation ±200°/s, 6000°/s²
RESPONSE TIME less than 7.5 min
RE-ALIGNMENT TIME less than 3.0 min
AZIMUTH ACCURACY less than 0.7 mil (1 sigma)

ELEVATION ACCURACY less than 0.5 mil (1 sigma)
POSITION ACCURACY less than 0.25% of distance travelled

in all axes

POWER SUPPLY 28 V DC

Status: Production. In service with M270 AVMRL users – Bahrain, France, Germany, Italy, the Netherlands, Turkey, the United Kingdom and the USA.

Manufacturer: AlliedSignal Aerospace Company, Land Vehicle Systems Marketing, Bendix Guidance Systems Division, Teterboro, New Jersey 07608, USA.

Telephone: (201) 393-2791/393-2138

Bendix Artillery Pointing System (APS)

Development/Description

The Bendix APS provides artillery units with an 'on-the-gun' solution to the orientation and laying of the howitzer in azimuth and elevation. The APS is a gun-mounted, self orientating azimuth and attitude system that provides each howitzer with a semi-autonomous operational capability. It provides the gunner with a greatly simplified and accurate means of laying the gun without having to set bubbles or use a panoramic telescope. Additionally, the Chief-Of-Section (COS) can verify the accuracy of the lay with his numerical display and confirm the lay between rounds without leaving his position.

The process of self-orientation takes place in 2.5 minutes from the simple initialisation process, during which the COS can enter firing orders. When the COS display indicates 'ready' the gunner can respond to his display commands with the COS monitoring the gunner's action. This would allow a full APS-equipped battery to come into action in 2.5 minutes from gun emplacement.

The APS consists of three subsystems: the APS Unit; COS Display; and Gunner's Display. It is based on ring laser technology and uses a MIL-STD-1750A microprocessor with comprehensive Built-in Test and an RS422 interface.

SPECIFICATIONS

WEIGHTS
APS Unit 12.3 kg
COS Display 1.4 kg
Gunner's Display 1.1 kg
DIMENSIONS

APS Unit 342.9 × 203.2 × 246.4 mm
COS Display 101.6 × 38.1 × 185.4 mm
Gunner's Display 109.2 × 109.2 × 57.2 mm

ALIGNMENT ACCURACY <1 mil ALIGNMENT TIME 2.5 min

OFF-LEVEL ALIGN equal to or less than 10° cant

ELEVATION ACCURACY <0.5 mil
POWER SUPPLY 22 to 36 V DC

Status: Ready for production.

Manufacturer: AlliedSignal Aerospace Company, Land Vehicles Systems Marketing, Bendix Systems Guidance Division, Teterboro, New Jersey 07608, USA.

Telephone: (201) 393-2791/393-2138

AlliedSignal Gyrocompass Navigation System (GNS)

Development/Description

The GNS has been designed as a general purpose navigation system with programmable waypoint navigation and targeting information facilities. It can be used on a wide variety of military vehicles including armoured vehicle turrets of ferrous construction.

The GNS consists of the following subsystems:

- a) a gyro-based Heading Reference Unit (HRU)
- b) a Navigation Display Unit (NDU)
- c) a Distance Measurement Unit (DMU)
- d) an optional Heading Indicator Unit (HIU).

The technology employed in the GNS has been adapted from the Stabilisation Reference Package (SRP) and North Seeking Gyrocompass (NSG) systems being provided to the US Army's MLRS and FISTV programmes. Where feasible, SRP/NSG inertial components and software have been utilised to provide logistics commonality.

SPECIFICATIONS

WEIGHT
HRU 9.1 kg
NDU 1.8 kg
DMU 0.68 kg
HIU 0.91 kg

DIMENSIONS

HRU 292.1 x 269.2 x 190.5 mm

NDU 228.6 x 127 x 50.8 mm

DMU 114.3 mm length x 63.5 mm

DMU 114.3 mm length x 63.5 mm diameter HIU 88.9 x 88.9 x 40.6 mm

POWER SUPPLY 24 ± 6 V DC

ALIGNMENT ACCURACY less than 1°

ALIGNMENT TIME

cold start 5 min re-alignment less than 3 min

stored heading alignment 1 min

POSITION ACCURACY less than 2% of distance travelled

Status: Trials.

Manufacturer: Enquiries to AlliedSignal Aerospace Company, Land Vehicle Systems Marketing, Bendix Guidance Systems Division, Teterboro, New Jersey 07608, USA.

Telephone: (201) 393-2791/393-2138

AlliedSignal Ring Laser Gyro Land Navigation System (RLNS)

Development/Description

The RLNS is an odometer-aided, strapdown, inertial, navigation system employing ring laser gyros and linear accelerometers to stabilise the inertial frame and develop the vehicle attitude, weapons aiming and navigation data. A set of unique aided inertial navigation system algorithms provide immunity to odometer anomalies caused by skid, slip and scale factor variation

The RLNS is aimed at the US Army's requirement for a high performance aiming and navigation system for current and future high mobility applications. It uses an inertial sensor assembly with a 1750A microprocessor and Ada software, and adaptive (expert system) Kalman filter, RS422 or 1553B interface, comprehensive (95%) Built-In Test (BIT) facility and a prognostics capability.

SPECIFICATIONS (provisional)

WEIGHT DIMENSIONS POWER SUPPLY ALIGNMENT ACCURACY ALIGNMENT TIME cold start POSITION ACCURACY

ROLL/ELEVATION ACCURACY HEADING DRIFT LATITUDE RANGE

Status: Trials

less than 10.75 kg 321.1 x 273.1 x 218.9 mm 28 V DC less than 0.5 mil

15 min 10 m or 0.1% DT vertical 10 m or 0.2% DT horizontal less than 0.3 mil 0.03 mil/h

75°N to 75°S

Manufacturer: Enquiries to AlliedSignal Aerospace Company, Land Vehicle Systems Marketing, Bendix Guidance Systems Division, Teterboro, New Jersey 07608, USA

Telephone: (201) 393-2791/393-2138

AlliedSignal Multiple Rocket Launcher System Position Navigation Unit (PNU)

Development/Description

In January 1993 AlliedSignal Guidance and Control Systems were selected by the MLRS prime contractor, Loral Vought Systems, to provide the engineering and manufacturing development phases of a four year development program for a ring laser, gyro based land navigation, pointing and stabilisation system for the improved fire-control system.

With built-in interfaces for the Global Positioning System (GPS) the PNU will allow positioning data to be automatically transferred from the GPS to the PNU. The PNU will then provide attitude and position information to the fire-control system which computes the ballistic data for the MLRS weapon payload. Production is expected to run for 10-15 years and will be worth approximately \$500 million to AlliedSignal.

Status: Development phase.

Manufacturer: AlliedSignal Aerospace Company, Land Vehicle Systems Marketing, AlliedSignal Guidance and Control Systems, Teterboro, New Jersey 07608, USA.

Telephone: (201) 303-2791/393-2138

Honeywell Modular Azimuth Position System (MAPS)

Development

The Honeywell MAPS medium accuracy land navigation system is in production for installation aboard the US Army self-propelled M109A6 Paladin howitzer and Firefinder II vehicles. The initial 1989 \$5.7 million contract's delivery options include as many as 2100 MAPS over five years. These options, together with the associated warranty and maintenance options, are valued at more than \$230 million.

In early 1988, the British Army selected Honeywell MAPS for use on the Warrior Mechanised Artillery Observation Vehicle, with production units already being delivered. In 1990, the Canadian Armed Forces selected Honeywell MAPS as a land navigation/survey standard. The Swedish FMV also selected the Honeywell MAPS as the Swedish Army standard for installation on the BKAN-1 self-propelled howitzer, TGR-11 survey vehicles and FH-77B 155 mm howitzer.

Other vehicle types tested with MAPS onboard have included the M113 tracked APC, Lance battlefield system, NBC reconnaissance vehicle and the HMMWV wheeled vehicle. Demonstrated performance has exceeded the military specification requirements by considerable margins in practically all areas

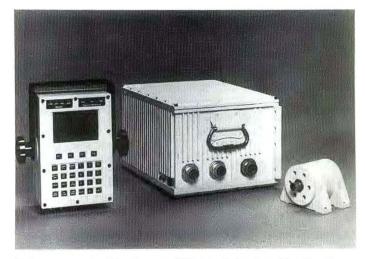
The Honeywell MAPS was used in combat during Operation Desert Storm by the British Army on its Warrior MAOV.

The system is based upon a strapdown inertial system using ring laser gyro technology developed by Honeywell. The main subsystems are

- (a) Dynamic Reference Unit (DRU) which uses a Ring Laser Gyro (RLG) assembly.
- (b) Control Display Unit (CDU)
- (c) Vehicle Motion Sensor (VMS)
- (d) interconnecting cable set and equipment mounting brackets. In operation it provides:
- (a) azimuth reference (from true North)
- (b) elevation
- (c) pitch and roll
- (d) outputs in UTM co-ordinates
- (e) outputs angular velocity rates
- (f) continuous output during vehicle movement.

MAPS can aid or enhance the operational readiness of a unit by use of the following capabilities:

- (a) during a rapid start-up, the system can recall from its memory the last values of heading and position when the vehicle stopped, thus eliminating the need for an initial alignment to begin navigating
- (b) in a normal alignment operation it performs a self-levelling procedure and then aligns itself to true North. The time taken for this is less than 15 minutes and, when completed, does not need to be periodically repeated as the equipment 'trims' the azimuth at each zero velocity update point during the system operation
- (c) for high accuracy missions a built-in test function (MAPS AUTOTRIM) periodically checks and corrects the accelerometer and gyro performances. Thus, once the initial factory calibration has been done, no further calibrations need to be made



Main components of the Honeywell Modular Azimuth and Position System (MAPS) are (left to right), the Control and Display Unit (CDU), Dynamic Reference Unit (DRU) and the Vehicle Motion Sensor (VMS)

(d) during any long distance vehicle movements, such as a road march to the next area of deployment, it is not necessary to perform a zerovelocity update more than once per hour. This is enough to ensure that the high navigational accuracy of the system is maintained.

The continuous information supplied by the MAPS at any point in time during a mission includes: the azimuth reference from true North; the vehicle elevation, pitch and roll; the UTM co-ordinates (as Northing, Easting and altitude values); the angular rates (which is particularly useful as this allows real-time stabilisation of weapons and sensor packages, as well as the transfer of alignment data to missiles to initialise their inertial guidance units); and, if required, latitude and longitude output.

SPECIFICATIONS

REACTION

WEIGHT DIMENSIONS POWER SUPPLY INTERFACE RELIABILITY ACCURACY

20.45 kg 221 × 273 × 381 mm 24 V DC RS422 (1553B option) 4000 HRS MTBF 1 mil pointing Instant on

POWER 100 W nominal (no heater required) No cooling air required

Status: Production. In service with the British Army (on Warrior Mechanised Artillery Observation Vehicles) and the US Army (on M109A6 howitzers and Firefinder II battlefield surveillance radar vehicles).

Manufacturer: Honeywell Military Avionics Division, 11601 Roosevelt Blvd, St Petersburg, FL 33716, USA.

Telephone: (813) 579-6807 Fax: (813) 579-6832

Kearfott Modular Azimuth Position System (MAPS)

Development

The Kearfott MAPS, originally developed to provide a self-contained navigation and direction-pointing reference system for the US Army's M109 Howitzer Improvement Programme (HIP), was selected in November 1989 by Vickers Shipbuilding & Engineering Ltd (VSEL) after a two-year international competition for fitting to the 179 British Army AS90 155 mm self-propelled howitzers ordered in July 1989. Two MAPS units were trialled in AS90 prototype vehicles.

An order for 204 systems plus spares was placed by VSEL with a further 60 units on option. Deliveries started in 1991 with the contract valued at over \$21 million. In April 1991 the Norwegian Army Military Command awarded a contract to Kearfott to supply its MAPS system for the Norwegian Artillery Battery Survey Equipment (NABSE)

Other typical applications, apart from the M109, include the M113 APC family and the M998 series (4 x 4) HMMWV light vehicle family

Description

The MAPS comprises three major subsystems:

(a) Dynamic Reference Unit (DRU), which contains an inertial platform consisting of three orthogonally mounted Ring Laser Gyros (RLGs) and accelerometers and 10 electronic cards. When coupled to the VMS through a Kalman filter in the DRU, as it passes over different terrain it provides the azimuth, XYZ position data, roll and pitch information by developing automatic calibration results. An RS422 output interface is fitted, as can special gun data outputs



The Dynamic Reference Unit (DRU) of the Kearfott Modular Azimuth Position System

- (b) Control Display Unit (CDU), which provides the control to the system through a multi-functional keyboard and displays the navigational and directional data as well as the operational status of the system on demand
- (c) Vehicle Motion Sensor (VMS)
- (d) interconnecting cable set and equipment mounting brackets.

The MAPS can be integrated directly into the fire-control system of a land or armoured vehicle and could be used with the Global Positioning System (GPS) (qv next entry).

The system can obtain its initial position data from a survey control system such as the GEC Ferranti PADS Mk 1 or Mk 2. The direction is provided by the action of the gyros and requires no survey alignment. The MAPS achieves its full operational capability within 15 minutes of start-up and has a quick reaction alignment time of less than five minutes.

The MAPS can provide location accuracy to 10 m (or 0.15% of the distance travelled) in the vertical plane. Directional accuracies of 0.5 to 1.0 mils are maintained during all operations. The latitude limits of the system are 75° N and 75° S. A total of 10 preset waypoints can be used with the system navigational output provided in UTM and British National Grid co-ordinates.

SPECIFICATIONS

WEIGHT	
DRU	22.73 kg
CDU	1.64 kg
VMS	0.91 kg
DIMENSIONS	

DRU 382.3 × 327.7 × 221 mm 203.2 × 101.6 × 63.5 mm CDU 81.3 × 76.2 × 76.2 mm VMS 400°/s

ANGULAR VELOCITY CAPABILITY

ANGULAR ACCELERATION

CAPABILITY 6000°/s2

ACCURACY

10 m RMS or 0.15% of distance horizontal

travelled

vertical 10 m RMS or 0.1% of distance travelled

0.5 to 1.0 mil RMS

azimuth ALIGNMENT TIME

cold start 15 min quick reaction 5 min LATITUDE LIMITS

75° N to 75° S POWER SUPPLY 28 V DC nominal (16-32 V)

Status: Production. In service with the British Army (AS90 self-propelled howitzer). On order for Norwegian Army (survey vehicles), Swiss Army (155 m howitzer update), Japanese Self Defence Forces (Patriot launcher).

Manufacturer: Kearfott Guidance and Navigation Corporation, 150 Totowa Road, Wayne, New Jersey 07474-0946, USA

Telephone: (201) 785 6000 Telex: 133440 Fax: (201) 785 6025

Kearfott Modular Azimuth Positioning System with Global Positioning System (MAP/GPS)

Development/Description

The MAPS/GPS is the Kearfott MAPS (qv previous entry) fitted with a universal RS422 interface to allow the use of standard off-the-shelf ruggerised GPS components to improve battlefield accuracy and increase operational survivability. The MAPS/GPS permits 'turn-on and go' without the need to await initial alignment for land and amphibious vehicles whilst providing better long-term navigation accuracy

The MAPS/GPS comprises the following subsystem:

- (a) Dynamic Reference Unit (DRU)
- (b) Control Display Unit (CDU)
- (c) Vehicle Motion Sensor (VMS)
- (d) GPS receiver
- (e) GPS antenna
- (f) interconnecting cable set and vehicle mounting brackets.

The MAPS/GPS is currently under development and in the process of evaluation testing

SPECIFICATIONS

ACCURACY

WEIGHTS	
DRU	22.73 kg
CDU	1.64 kg
VMS	0.91 kg
GPS receiver	1.3 kg
GPS antenna	0.35 kg
m 11 1m 1 m 1 m 1 m 1 m	

DIMENSIONS DRU $382.3\times327.7\times221~\text{mm}$ CDU 203.2 × 101.6 × 63.5 mm VMS $81.3 \times 76.2 \times 76.2 \text{ mm}$ GPS receiver 127 × 241.3 × 50.8 mm GPS antenna 92.25 × 101.6 × 137.2 mm

horizontal 10 m CEP bounded error vertical 10 m PE bounded error

0.67 mils moving base alignment all azimuth

latitudes 28 V DC nominal

POWER SUPPLY

Status: Development. In process of evaluation trials.

Manufacturer: Kearfott Guidance and Navigation Corporation, 150 Tototowa Road, Wayne, New Jersey 07474-0946, USA

Telephone: (201) 785 6000 Telex: 133440 Fax: (201) 785 6025

Kearfott Land Navigation System (LNS) for Combat/Surveillance Vehicles

Development/Description

The LNS uses the GYROFLEX gyroscope, advanced accelerometers and state-of-the-art electronics to provide fully autonomous vehicular land navigation functions. It can be installed in most military vehicles including jeeps, APCs, missile launchers and tanks and has been found by field artillery commanders to be particularly effective in deploying artillery units. The combat commander, by using either the map display unit or tracking plotter, can also follow his course of manoeuvres on standard tactical maps and can retain a record of his entire path.

After extensive evaluation the Egyptian government ordered a total of 270 systems in 1985. These have been delivered and been installed on CJ-8 jeeps, the Artillery Target Location Vehicle, Chaparral missile launch vehicles and Trackstar. In 1990 Loral Aeronutronics ordered a further 39 systems for use on Egyptian vehicles (30 for Chaparral and nine for Trackstar). These have also been delivered.

The LNS comprises the following subsystems:

- (a) Heading Reference Unit (HRU) consisting of: an inertial sub-assembly with a gyro stabilised platform, two gimballed structure and two single axis accelerometers; control electronics; and a baro-altimeter for precise measurement of altitude
- (b) Computer Display Unit (CDU) consisting of: computer software and hardware; easily readable numeric displays; and primary power supply interruption protection
- (c) Distance Transmitter Unit (DTU) which provides the distance travelled input by use of an electro-optical device and is driven by a vehicle odometer cable pick-up
- (d) Optional Map Display Unit (MDU) which consists of a microcomputer controlled 400 × 400 mm roller map with X and Y direction plots, continuous 4-digit readout display and hinged transparent cover for map protection.

The LNS system has Built-in Test (BIT) and position recall after system shutdown/startup. It also has a steer-to-capability and can calculate forward co-ordinates. A total of 30 waypoints can be stored.

SPECIFICATIONS

WEIGHTS HRU 15.91 kg CDU 7.27 kg 0.23 kg DTU MDU 25 kg DIMENSIONS

HRU 355.6 × 228.6 × 203.2 mm CDU 241.3 × 165.1 × 158.75 mm $50.8\times50.8\times76.2~\text{mm}$ DTU MDU 635 × 508 × 203.2 mm

HEADING ACCURACY 1 deci HEADING DRIFT RATE 1 deci/h

NAVIGATION ACCURACY better than 0.35% of distance travelled UTM FORMAT DISPLAYS Eastings, Northings, Altitude, Zone MAP SCALES 3 (1:25 000; 1:50 000; 1:100 000) STORED WAY POINTS

CALL UP DISPLAYS True heading, Grid heading with heading in degrees, mils, deci

less than 3 min

START UP TIME POWER SUPPLY

Status: Production as required (Over 300 built by January 1993). In service with Egypt.

Manufacturer: Kearfott Guidance and Navigation Corporation, 150 Tototowa Road, Wayne, New Jersey 07474-0946, USA.

Telephone: (201) 785 6000 Telex: 133440 Fax: (201) 785 6025

Kearfott Miniature Integrated Land Navigation System (MILNAV)

Development/Description

The MILNAV uses a miniature three-axis ring laser gyro, three single-axis accelerometers and associated electronics to provide land navigation functions. The system can accept Global Positioning Satellite (GPS) or other update information to further enhance its performance.

The MILNAV comprises the following subsystems:

- (a) Inertial Reference Unit (IRU) consisting of an inertial system with a three-axis ring laser gyro and three single axis accelerometers
- (b) Command Display Unit (CDU) consisting of portable computer software and hardware
- (c) Vehicle Motion Sensor (VMS) which provides the vehicle motion

The MILNAV system has automatic self-test, ZUPT capability and way point selection capabilities. It is also NBC compatible. An RS422 interface or MIL-STD-1553B are optional.

SPECIFICATIONS

WEIGHTS

5.45 kg Standard MILNAV 6.82 kg GPS aided MILNAV

DIMENSIONS 177.8 × 177.8 × 279.4 mm

POSITION ACCURACY

Standard MILNAV 0.5% of position travelled GPS aided MILNAV 10 m CEP

MOVING ALIGNMENT

AZIMUTH ACCURACY 2 mil (±65° latitude) Standard MILNAV

GPS aided MILNAV 1 mil (±65° latitude)

POWER SUPPLY

Status: Development. Under tests in 1992 by UK MOD/DRA.

Manufacturer: Kearfott Guidance and Navigation Corporation, 150 Tototowa

Road, Wayne, New Jersey 07474-0946, USA.

Telephone: (201) 785 6000 Telex: 133440 Fax: (201) 785 6025

Magellan NAV 1000 M5 Global Positioning System (GPS) Receiver

Development/Description

The small, ruggedised, portable, lightweight Magellan NAV 1000 M5 GPS receiver was widely used in the 1991 Gulf War by a number of Coalition Force members for applications such as vehicle and troop positioning and

The NAV 1000 M5 makes use of the NAVSTAR Global Positioning System satellite network and when the 21 satellite constellation (plus three in-orbit spares) is finally completed in 1994, it will allow highly accurate positional calculations to be performed at any point on the Earth.

The NAV 1000 M5 comprises the following components:

- (a) a rugged conductive rubber keypad with single function only button keys
- (b) a backlit, four-line, 16-character, alphanumeric easy-to-read 65 × 45 mm sized LCD display with 7 mm high digits (and a cursor)
- (c) an integrated quadrifilar exterior antenna for enhanced signal reception from satellites laying near the horizon.

If required a remote antenna kit (with 15 m of cable) and a quick release bracket set can be supplied for adapting the unit for use in vehicles such as MBTs, HMMWVs and helicopters. Electrical considerations for these applications are handled by the use of either a 12 V or 20-40 V DC adapter or 115, 220 or 240 V AC adapter.

Following the systems success in the Gulf War, additional functions have been added to produce the following functions/capabilities list:

(a) updating every second for continuous position, navigation and velocity data - the NAV 1000 M5 reads a minimum of three best positioned satellites for 2D positional fixes (solves, with a user entered altitude,

- calculations for latitude, longitude and time) and four best positioned satellites for 3D positional fixes (solves calculations for lattitude, longitude. altitude and time)
- Thus the data obtained allows speed and ground course, distance and bearing to objective, multi-leg route, altitude and cross-track error information to be used for navigational purposes
- (b) averages a position accuracy of 15 m (RMS) for 2D fixes and 20 m (RMS) for 3D fixes
- (c) has a single position accuracy of 25 m (RMS) for 2D fixes and 30 m (RMS) for 3D fixes
- (d) the positional co-ordinates can be displayed in Military Grid Reference System (MGRS), LAT/LON or Universal Transverse Mercator (UTM)
- (e) the headings can be displayed in mils, radians or degrees
- the multi-leg route key can be used when undertaking accurately timed and co-ordinated missions
- (g) the unit has stored up to 46 military mapping agency datums with one additional user defined datum
- (h) the unit can have up to 100 user defined waypoints stored
- the unit allows a forward observer, forward air controller or special forces operative to accurately calculate a target's position by providing location, distance and directional information
- the unit allows a field commander to download essential positional information via the RS232 data transfer output port to subordinate unit leaders for mission synchronisation and planning purposes in time and
- (k) the unit monitors GPS satellite schedule, satellite signal strength and geometry, satellite status (elevation and azimuth) and allows satellite selection to be undertaken

6 AA batteries (typically up to 7 h

continuous operational life)

fast sequencing

25 m (RMS)

30 m (RMS)

15 m (RMS)

20 m (RMS)

870 kts

0.75 g

2.5 mins

3 mins

45 s

SPECIFICATIONS

DIMENSIONS (excluding antenna) 215 × 90 × 50 mm WEIGHT (with batteries) 0.85 kg

POWER SUPPLY

RECEIVER

typical 2D

POSITIONAL ACCURACY

single 2D single 3D averaging 2D averaging 3D MAX VELOCITY

MAX ACCELERATION (tracking) TIME TO FIRST FIX

typical 3D TIME TO QUICK FIX (typical)

TIME TO SUBSEQUENT FIX typical 2D

1 5 typical 3D

Status: Production. In service with a number of undisclosed countries.

Manufacturer: Magellan Systems Corporation, 960 Overland Ct., San

Dimas, CA 91773, USA

Telephone: (909) 394 5000 Fax: (909) 394 7050

Magnavox MX7120 with Remote Control Display Unit

Development/Description

The MX7120 is a Magnavox developed six channel, L1-band (1575 MHz), C/A code, differential capable Global Positioning System (GPS) receiver. Designed for rugged environments, the system is tested to the US DoD environmental requirements for vehicle and man-portable applications.

The use of three custom built Application Specific Integrated Circuit (ASIC) units and surface-mount technology has permitted the construction of a low cost and architecturally sophisicated six-channel receiver.

A Remote Control Display Unit (RCDU) has been developed for use with the MX7100 series. For the MX7120 the RCDU provides the user with the capability to operate autonomously with the system in military vehicle and other applications.

For specific applications the differential GPS techniques may not be practical. The GPS provides for a Standard Positioning Service (SPS) and a Precise Positioning Service. The SPS signal is intentionally degraded by national American policy to provide, on average, a 100 m 2dRMS accuracy. The Precise Positioning Service is primarily intended for authorised (typically military) users

Through Preplanned Product Improvement (P3I) the MX7120 receiver has been designed to permit incorporation of the Magnavox Precise Position Security Module (PPS-SM). The PPS-SM is an integrated circuit that, when properly keyed with crytographic material, permits access to the Precision Positioning Service, access to which provides upgraded navigation, position location and time accuracy.

Status: Production. In service with the US Army and several undisclosed

Manufacturer: Magnavox Electronic Systems Co, West Coast Division, 2829 Maricopa St, Torrence, CA 90503, USA. Telephone: (310) 618 7036 Fax: (310) 618 7001

Magnavox GPS Engine™ Turbo Version

Development/Description

The GPS Engine™, Turbo Version is a high performance six channel, L1-band C/A code receiver that provides Global Positioning System (GPS) power for embedded applications requiring US Army environmental standards for vehicle and manportable applications.

With six parallel channels the system simultaneously tracks and processes all of the GPS signal from up to six satellites. Continuous tracking provides greater sensitivity than other types of receiver: typically 4-5 dB over sequential receivers and 8 dB better than multiplexed receivers. Each of the channels in the GPS Engine, Turbo tracks both code and carrier phase independently for smoother navigation results and greater potential accuracies

The simultaneous collection of data fom six satellites provides better position accuracy by averaging out all system errors at a single point in time. Continuous redundant tracking also ensures uninterrupted navigation under adverse conditions, and when signals from one or more of the satellites are blocked.

The PCB is configured with custom analog devices and six-channel baseband. Data output provides position, speed vectors, time, altitude and GPS status information. Differential GPS and time recovery capabilities are inherent in the receiver's architecture and are available as standard features

The GPS provides for a Standard Positioning Service (SPS) and a Precise Positioning Service. The SPS signal is intentionally degraded by national American policy to provide, on average, a 100 m 2dRMS accuracy. The Precise Positioning Service is primarily intended for authorised (typically military) users. For approved users installation of the Magnavox Precise Position Security Module (PPS-SM) can be performed. The PPS-SM is an integrated circuit that, when properly keyed with crytographic material, permits access to the Precision Positioning Service, access to which provides upgraded navigation, position location and time accuracy.

SPECIFICATIONS

DIMENSIONS

110.5 × 130.8 × 12.7 mm

POSITION ACCURACY with SA

40 m CEP

with PPS-SM with DGPS

15 m CEP 2 - 5 m CEP

Status: Production. In service with the US Army.

Manufacturer: Magnavox Electronic Systems Co, West Coast Division, 2829 Maricopa St, Torrence, CA 90503, USA

Telephone: (310) 618 7036 Fax: (310) 618 7001

Smiths Industries Model 9265 Vehicle Navigation Aid System (VNAS)

Development/Description

The Model 9265 VNAS is a small, lightweight, modular, land navigation system designed for use with the US M1 Abrams and M60 MBTs, M2 Bradley IFV, M113 APC, M901 Improved TOW Vehicle (ITV), Fast Attack Vehicle (FAV), Light Armored Vehicle (LAV), High Mobility Multi-purpose Wheeled Vehicle (HMMWV), the Armored Amphibious Assault Vehicle (AAV) and similar vehicles worldwide.

It comprises: a Navigation Display Unit (NDU) which presents all the navigation and system status data and uses a microprocessor with a nonvolatile memory so that, even if the system is turned off and then on again at a later date, the data is retained for use; a Vehicle Reference Unit (VRU) with a strapdown gyro that aligns itself to true North and senses the vehicle heading and attitudes; a Distance Measurement Unit (DMU) and a Vehicle Heading Indicator (VHI).

Before operations commence the vehicle's start position co-ordinates

and its heading must be initialised. Once these operations are completed the mode switch is placed in the 'operate' position and the function switch to 'press pos' so that the display will show the vehicle's current position in eight digit UTM (geographic) co-ordinate form. It will also continuously display vehicle grid heading in degrees or mils depending upon operator choice.

If the UTM co-ordinates of a position are entered by the system operator the equipment will provide range and heading to this position. The VNAS in its 'target' mode will also permit entry of range data to a target from, for example, a laser rangefinder and turret angle information from the turret angle indicator, so that the microprocessor can calculate the eight-digit UTM co-ordinates of the target, allowing the direction of a highly accurate artillery or air strike.

A course line can be established by entering the position at which a course is to be terminated. Should the vehicle stray from that course, the correct range and heading to return to the course will be displayed.



Smiths Industries Vehicle Navigation Aid System components: VHU (top left), NDU (top right), VHI (bottom left), DCCU (bottom centre) and DMU (bottom right)

VNAS has the capability to interface with the Global Positioning Satellite (GPS) system should that feature be required.

SPECIFICATIONS

WEIGHT

Vehicle Reference Unit 4.55 kg Navigation Display Unit 1.14 kg 0.32 kg Vehicle Heading Indicator Distance Measurement Unit 0.82 kg

POSITION ACCURACY 2% (1 sigma) of distance travelled

ALIGNMENT ACCURACY ±1° (1 sigma)

Status: Production. In service with the US Marine Corps and several unspecified countries.

Manufacturer: Smiths Industries, 4141 Eastern Avenue, S.E., Grand Rapids,

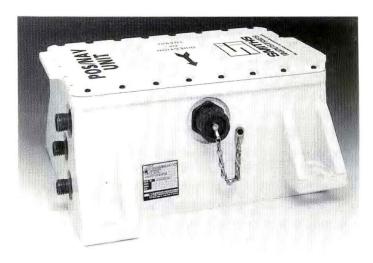
Michigan 49518-8727, USA. Telephone: (616) 241 7000 Telex: 4320036

Note: this was previously the Lear Siegler VNAS.

Smiths Industries POS-NAV Position Navigation System

Development/Description

The POS-NAV system is currently in production for use by General Dynamics in the US Army's M1A2 Abrams programme. It allows the tank crew to position their vehicle accurately while driving at combat speeds thus eliminating the need to stop and orientate their maps to key features of terrain. It can also enhance control and direction of indirect fire and Close Air Support (CAS).



Smiths Industries Position/Navigation Unit

The system is based on technology from Smiths Industries aircraft flight navigation and management systems and the experience gained with the company's VNAS unit.

POS-NAV uses strapdown gyro technology for its operation. Distance travelled is derived from wheel or track rotation, as measured by an odometer. This is backed up by accelerometers located in the inertial reference unit.

Outputs are sent to the driver's position and a multi-function display at the commander's position. They will include: vehicle present position and heading; target co-ordinates as well as range and heading to a target; destination or navigation waypoint can be presented.

The system combination can also be used to input accurate position updates based on the known position of a visible landmark, even if it is a long way from the vehicle. It is also possible to set up a course-line, such as the boundary of a safe-area to stop if the vehicle strays out of its allotted area, and indicate the shortest way back to safety

POS-NAV has the capability to interface with the Global Positioning Satellite (GPS) system if desired.

SPECIFICATIONS (provisional)

4.5 kg WEIGHT

DIMENSIONS 305 × 180 ×150 mm

POSITION ACCURACY 2% of distance travelled per hour

ALIGNMENT ACCURACY HEADING INITIALISATION

5 min

Status: In production. Chosen by General Dynamics for the M1A2 Abrams

MBT programme.

Manufacturer: Smiths Industries, 4141 Eastern Avenue, S.E., Grand Rapids,

Michigan 49518-8727, USA. Telephone: (616) 241 7000 Telex: 4320036

Driver Day and Night Vision Systems

BELGIUM

Oldelft HNV-1 Holographic Goggles

Development/Description

The HNV-1 goggles are a lightweight, microchannel wafer, secondgeneration 18 mm wafer tube unit (with optional third-generation type tube) which uses Holographic Optical Element (HOE) technology to provide the user continuously with a see-through image of the real world without having to remove either the visor or goggles.

Using these goggles allows the operator to perform tasks at night such as driving or maintaining a vehicle under better conditions than could be achieved using more conventional individual operator night vision systems

SPECIFICATIONS

DISTORTION

WEIGHT approx 1 kg MAGNIFICATION

less than 7% FIELD-OF-VIEW 30° vertical 40° horizontal **FOCUS RANGE** 250 mm to infinity RESOLUTION at full moon (10-1 lux)

better than 3 mrad by starlight (10-3 lux) better than 5 mrad

BATTERY two 1.5 V AA size



Oldelft HNV-1 night vision goggles

Status: In series production. In service with the Belgian Army and unspecified

Manufacturer: OIP-Instrubel NV/SA, Member of the Oldelft Group. Westerring 21, B-9700 Oudenaarde, Belgium.

Telepone: (055) 333811

CHINA, PEOPLE'S REPUBLIC

NORINCO Type TDPN-2 Driver's Night Viewer

Development/Description

The NORINCO Type TDPN-2 driver's night viewer is a second-generation, bi-ocular, single tube, image intensifier system of the periscopic type for use in tanks or other AFVs.

The bi-ocular display allows the driver to view the low light level, image intensified screen at a distance of 50 mm from the large diameter eyepiece with both eyes while remaining seated in the normal driving position.

In physical appearance, components and operation the TDPN-2 is almost identical to the Israeli EL-OP company's Compact Driver's Night Viewer and may well be a licensed copy

SPECIFICATIONS

WEIGHT 7 ka LENGTH 360 mm WIDTH 162 mm DEPTH 186 mm FIELD-OF-VIEW 350

TRAVERSE ADJUSTMENT 30° left and right

FOCUS SETTING fixed

RESOLUTION 0.85 lp/mrad at 3×10^{-3} ft

MAGNIFICATION

Status: Production. In service with the Chinese Armed Forces

Manufacturer: NORINCO, China North Industries Corporation, 7A Yuetan

Nanjie, Beijing, People's Republic of China.

Telephone: 86.6898/3471/7570/3461 Telex: 22339 CNIC CN



NORINCO tank driver's night viewer Type TDPN-2

NORINCO Type 1985 Passive Night Vision Goggles

Development/Description

The NORINCO Type 1985 passive night vision goggles are a lightweight night viewing system for use by individual soldiers who have to perform such duties as vehicle driving and vehicle maintenance.

The system uses two single-stage image intensifier tubes of the thirdgeneration type with focussable lens and adjustable eyepieces to achieve its results, and can be used with an infra-red light source as the illuminator for map or document reading.

When used the goggles are attached to the user's head by chin and head straps

SPECIFICATIONS

about 0.96 kg MAGNIFICATION FIELD-OF-VIEW 44

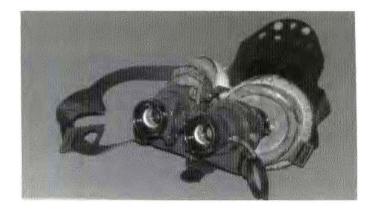
ANGULAR RESOLUTION (target contrast = 0.85) at 1 × 10-2 lux 2.8 mrad

at 1×10^{-3} lux 4 mrad FOCUS RANGE 300 mm to infinity

EYEPIECE DIOPTER RANGE +5 to -5

BATTERY NiCad

0.5 Ah capacity cell



Status: Production. In service with the Chinese Armed Forces.

Manufacturer: NORINCO, China North Industries Corporation, 7A Yuetan

Nanjie, Beijing, People's Republic of China.

Telephone: 86.6898/3471/7570/3461 Telex: 22339 CNIC CN

NORINCO passive night vision goggles Type 1985

COMMONWEALTH OF INDEPENDENT STATES

AFV Driver's Night Vision Equipment

Former Soviet armoured vehicles are known to be fitted with the following types of driver's night vision equipment:

TVN-2

This is an active infra-red driving periscope with a 34° field-of-view and is mounted on MBTs such as the T-54A, T-55 and T-62 in place of a standard vision block. Maximum range is in the order of 60 m with the driver having a bi-ocular eyepiece assembly to view through.

TVN-3

This is a later version of the TVN-2 and can be found on some late-model T-62s and the follow-on MBT designs.

Status: TVN-2 production as required. In widespread service. TVN-3 in production. In service with selected countries.

Manufacturer: Former Soviet state factories.

FRANCE

SOPELEM CN2-500 Passive Driving Periscope Series

Development/Description

The CN2-500 series is a range of second-generation passive driving periscopes which enable AFVs to be driven at night without the aid of artificial lighting.

Modules have been designed within the series to fit a range of vehicle types listed below:

- CN2-508: Panhard armoured vehicles, AMX-13 light tank and RVI vehicles
- 2) CN2-516: AMX-30 MBT, AMX-10 armoured vehicles and RVI vehicles
- 3) CN2-540: AMX-40 MBT
- 4) CN2-548: M48 MBT and derivatives
- 5) CN2-555: T-54, T-55 tanks and derivatives
- 6) CN2-559: Type 59 tanks, Type 69 tanks and derivatives.

The periscope is interchangeable with the daylight system and is fitted with a bi-ocular eyepiece enabling simultaneous viewing with both eyes by the driver without adjustment.



SOPELEM CN2-500 passive driving periscope series: left to right, models CN2-508, CN2-516 and CN2-555

As an optional extra, the equipment can be fitted with a light dimming device to allow daytime use in exceptional circumstances.

A CN2-500 series periscope contains three subsystems:

- a) optical module which contains the prism head and is encased within a light alloy housing
- b) mechanical module which contains the objective lens assembly and provides the means of fixing the system to the vehicle
- c) optronic module which contains a wide aperture lens, a secondgeneration TH 1313 microchannel inverter type light intensification tube made by Thomson-CSF, a prism, a power supply circuit and the bi-ocular vision system for the driver. All the components are contained within a light alloy casing.

The only modules specific to the vehicle type are the prism head and the housing.

SPECIFICATIONS

 DIMENSIONS

 CN2-508
 316 × 160 × 132 mm

 CN2-516
 308 × 192 × 137 mm

 CN2-548
 316 × 200 × 128 mm

 CN2-555
 316 × 152 × 128 mm

 CN2-559
 320 × 150 × 140 mm

 MAGNIFICATION
 × 1

FIELD-OF-VIEW horizontal 50° vertical 40°

RESOLUTION 1.5 mrad at 10 lux second-generation POWER SUPPLY 24 V DC vehicle system

Status: Production. In service with France and other unspecified countries.

Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimer Périer, PO Box 62, F-95872 BEZONS Cedex, France.

Telephone: (1) 34 23 30 00 Telex: 605793F

Fax: (1) 34 23 33 50

SOPELEM TN2-1 Night Vision Binoculars

Development/Description

The TN2-1 night vision binoculars are designed for general-purpose use including vehicle driving. They are head-mounted and utilise a single, second-generation, microchannel light-intensifier tube with a binocular eye configuration to provide user comfort. A single adjustment only is required to suit the operator's vision.

Power is supplied either by two 1.5 V AA-sized batteries or one larger 2.7 or 3.6 V battery. An integral LED unit provides additional illumination for close order work such as map reading.

Weight is 0.47 kg complete, magnification is \times 1 and the field-of-view is

Status: Production as required. In service with unspecified countries. Avimo Ltd of the United Kingdom has a licence to manufacture the TN2-1 night vision binoculars.

Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimer Périer, PO Box

62, F-95872 BEZONS Cedex, France. Telex: 605793F Telephone: (1) 34 23 30 00

Fax: (1) 34 23 33 50



SOPELEM TN2-1 night vision binoculars

Thomson-TRT Défense OB-31 Night-driving Periscope

Development/Description

The OB-31 periscope is designed to be interchangeable with the daylight

driving periscopes of the AMX-30 MBT, AMX-10 armoured vehicles and various other vehicle types (including the ERC Sagaie, EE-9 Cascavel,

Thomson-TRT Défense OB-31 night-driving periscope from driver's side

EE-11 Urutu and M48) to provide a combined day/night driving facility from broad daylight to starlight without the use of external aids such as headlights.

Two light-intensification tubes with suitable optical assemblies provide two separate viewing channels and allow stereoscopic vision. A manually operated diaphragm permits limiting of image brightness in high ambient levels. Protection of the image intensifier tubes against excessive brightness is provided by a special device within the optical system.

SPECIFICATIONS

DIMENSIONS $327\times193\times163~\text{mm}$

WEIGHTS

7.85 kg periscope

periscope 11.85 kg (with transport case)

MAGNIFICATION FIELD-OF-VIEW

horizontal 480 vertical 40°

Status: Production. In service with the French Armed Forces (approved for use on AMX-30 MBTs, AMX-10 and VAB armoured vehicles) and other unspecified countries.

× 0.9 (approx)

Manufacturer: Thomson-TRT Défense, Optronic Division, rue Guynemer,

BP55, F-78283 Guyancourt Cedex, France. Telephone: (1) 30 96 70 00 Telex: THOM 616780F

Fax: (1) 30 96 75 50

Thomson-TRT Défense OB-41 Night-driving Binoculars

Development/Description

The OB-41 passive night-driving vision binoculars have two separate microchannel image intensifier tubes with double proximity focus. In this way comfortable stereoscopic vision is obtained.

Weight is around 0.9 kg complete, magnification is x 1 and the field-ofview is 33°. The typical range is 250 m and, with the aid of a faint additional light source, the OB-41 can be used in very poor ambient lighting conditions (eg less than 10-4 lux) at distances of up to 10 m.

Status: In production. In service with the French Armed Forces and other unspecified countries.

Manufacturer: Thomson-TRT Défense, Optronic Division, rue Guynemer,

BP55, F-78283 Guyancourt Cedex, France.

Telephone: (1) 30 96 70 00 Telex: THOM 616780F

Fax: (1) 30 96 75 50



Thomson-TRT Défense OB-41 night-driving binoculars in use

Thomson-TRT Défense UGO Observation and Driving Goggles

Development/Description

The UGO modular goggle unit has been developed as a low cost solution to a wide range of visual observation and driving applications. The goggles have the following capabilities:

- (a) Day Observation which is achieved by classic 8 × 24 binocular glasses. The goggles are fixed onto a special mask to enable the user to have their hands-free. They feature a 'flip-up, snap-in' mounting.
- (b) Night Vision which is provided by an image intensifier channel that uses the same goggle eyepieces. The image intensifier tube is of the second generation type (with third generation an option). The × 1 magnification makes possible vehicle driving as well as various other tasks. The image intensifier tube switches off automatically when the light level radically increases.

A switch changes the day/night channels and also switches on a discreet IR light source which provides sufficient illumination for minor repairs or other tasks such as map reading on very dark nights.



Thomson-TRT Defense UGO day/night goggles

(c) Night Observation – a removable afocal lens is used for night observation tasks. Typically, this enables the user to identify a tank at 600 metres on a night with one millilux illumination.

SPECIFICATIONS

WEIGHT (without mask

or afocal lens) 0.7 kg
DIMENSIONS 140 × 140 × 60 mm

DIOPTER RANGE -5 to +5

POWER SUPPLY $1 \times 3.5 \text{ V AA}$ lithium battery or $2 \times 1.5 \text{ V AA}$

batteries

Daytime vision

MAGNIFICATION × 8 FIELD-OF-VIEW 6° INPUT LENS DIAMETER 24 mm

STEREOSCOPIC VISION
RESOLUTION ON AXIS 0.03 mrad/1p

TRANSMISSION 0.75

Night-time vision

 MAGNIFICATION
 × 1

 FIELD-OF-VIEW
 40°

 GAIN
 1000 min

 RESOLUTION ON AXIS
 1.6 mrad/1p

FOCUS RANGE 0.25 m to infinity
IMAGE INTENSIFIER 2nd generation 18

2nd generation 18 mm non-inverting (interchangeable with 3rd generation)

Night-time observation

MAGNIFICATION × 4
FIELD-OF-VIEW 10°
RESOLUTION ON AXIS 0.4 mrad/1p
FOCUS RANGE 10 m to infinity

Status: Production. First deliveries were made in 1992 against order from the French Army.

Manufacturer: Enquiries to Thomson-TRT Défense, Optronics Division, rue Guynemer, BP55, F-78283 Guyancourt Cedex, France.

Telephone: (1) 30 96 70 00 Telex: THOM 616780F Fax: 30 96 75 50

Thomson-TRT Défense OB-60 Day/Night Driver's Periscope

Development/Description

The OB-60 driver's periscope system has been chosen by the French Army to equip its Leclerc MBT. The OB-60 belongs to a family of day/night periscopes which includes large field-of-view systems (by internal night channel rotation) for the AMX-30 and AMX-10 and compact systems (without internal night channel rotation) for the Leopard I/Leopard II MBT or M113 armoured vehicle family.

This concept of day/night periscopes provides additional operational advantages, particularly in NBC conditions whereby:

- (a) no breaking of the driver's compartment seal occurs
- (b) there is no need to stop the vehicle to exchange the periscope for a day or night version so that no risk of damage to equipment occurs
- (c) there is no need for any storage space for the unused periscope.

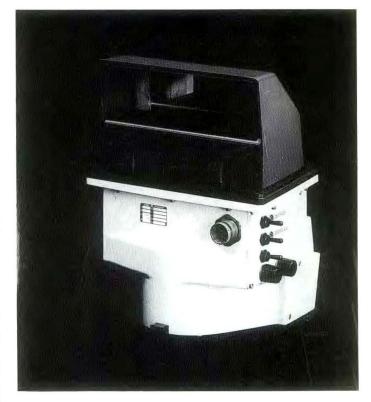
The OB-60 combines a conventional day channel prism and a passive night image intensifier channel with the capability to switch instantaneously from one to the other vision mode.

Although the periscope housing remains fixed, the $\pm 30^{\circ}$ azimuthal turning ability of the night vision channel provides a 100° horizontal field-of-view for night vision operations. For the latter, a second-generation image intensifier tube is used whereby the image is visualised into a large aperture biocular to ensure simultaneous vision to both eyes.

Other system capabilities include:

- (a) upper window defrosting
- (b) lower window defrosting
- (c) autolaser filter on day channel
- (d) automatic cut-off and shielding of the image intensifier tube, on day vision mode
- (e) automatic cut-off of the image intensifier tube in event of prolonged exposure to high light levels, on night vision mode.

For emergency use the periscope has an image generating unit through which six different message symbols can be displayed in the lower half of the driver's field-of-view. These symbols are sent by the vehicle commander and relate to emergency driving instructions. They can be displayed whilst in either periscope operating mode.



Thomson-TRT Défense OB-60 driver's periscope

SPECIFICATIONS

Day channel FIELD-OF-VIEW

80 horizontal 25 vertical

Night channel

MAGNIFICATION $\times 0.92$

FIELD-OF-VIEW full horizontal azimuthal rotation 100

instantaneous horizontal 45 30° (45° total)

instantaneous vertical

RESOLUTION (contrast = 0.9) 101 lux

10-3 lux 2 mrad/pl FOCUS DEPTH 10 m to infinity 0.5 diopter **BI-OCULAR FOCUSSING** GAIN > 2000

Status: In production. In service with the French Army on Leclerc MBT.

Manufacturer: Thomson-TRT Défense, Optronic Division, rue Guynemer.

BP55, F-78283 Guyancourt Cedex, France Telephone: (1) 30 96 70 00 Telex: THOM 616780F Fax: (1) 30 96 75 50

Co-producer: SOPELEM-SOFRETEC, 53 rue Casimer Périer, PO Box 62,

F-95872 BEZONS Cedex, France. Telex: 605793F Telephone: (1) 34 23 30 00

Fax: (1) 34 23 33 50

ISRAEL

Astronautics Tank's Driver Control and Display Panel

1.2 mrad/pl

Development/Description

The tank's driver control and display dash board is designed to integrate all hull control and display systems on a single comprehensive console. The board comprises the following functional sub units

System Control Panel - which includes the following functions: lights, various hull systems and driver's station functional switches such as ignition, power-up and fuel pumps operation and so on



Astronautics tank's driver control and display panel

- A main system computer which interfaces with the engine, gear and fuel systems, remote turret display and other auxiliary hull systems to monitor status, functional range and data for maintenance purposes
- An advanced Liquid Crystal Display (LCD) driver's parameter display which presents all the driver's relevant data such as speed, engine rpm, engine and oil temperatures and pressures, battery charging rate and status, warning indicators and so on.

SPECIFICATIONS

DIMENSIONS 475 × 150 × 260 mm

WEIGHT 10 kg

EFFECTIVE DISPLAY AREA

55 × 125 mm upper display 70 × 125 mm lower display

SIGNAL INPUTS

Signal	Input	Display Range	Display Resolution
engine rpm	analog DC	0-3000 rpm	analog 250 rpm digital 50 rpm
speedometer	analog AC	0-80 km/h	5 km/h
fuel quantity	analog DC	0-1550	50 1
engine oil temperature	analog DC	130-300°F	15°F
engine oil pressure other	analog DC discrete	0-100 psi	10 psi

Status: Production as required. In service with the Israeli Defence Force.

Manufacturer: Astronautics C A Limited, 23 Hayarkon Street, PO Box 882,

IL-51261 Bnei Brak, Israel.

Telephone: (03) 5791555 Telex: 341294 Fax: (03) 5704404

EL-OP No 5157 Second-Generation Night Vision Goggles

Development/Description

The EL-OP Night Vision Goggles are a second-generation passive viewing system which uses two focussable objective lenses, two image intensifier



EL-OP No 5157 second-generation night vision goggles

tubes and two adjustable eyepiece units affixed to the operator's facemask, which is held in place by self-tightening head straps.

For viewing control panels, maps or documents a built-in auxiliary infrared light source is provided. All the operator has to do is switch on and adjust the system for correct viewing. Once this is completed he has his hands free for driving the vehicle or performing other tasks such as vehicle maintenance in darkness. The goggles use the ambient moonlight or starlight as the source of illumination.

SPECIFICATIONS

WEIGHT 1 ka MAGNIFICATION \times 1 FIELD-OF-VIEW 40° 500 GAIN ANGULAR RESOLUTION 1.5 mrad **FOCUS RANGE** 250 mm to infinity EYEPIECE DIOPTER RANGE +2 to -6

2.7 V Mallory 303843 BATTERY

Status: In production. In service with unspecified countries.

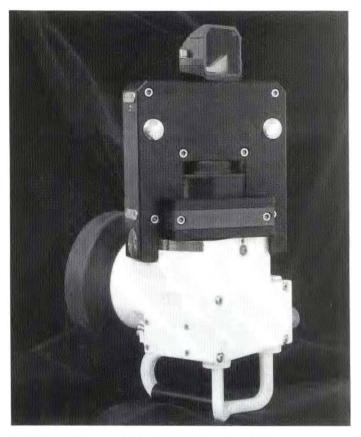
Manufacturer: EL-OP Electro-Optics Industries Limited, Advanced Technology Park, Kiryat Weizmann, POB 1165, IL-76110 Rehovot, Israel. Telephone: (08) 386221 Telex: 381344 Fax: (08) 386237

EL-OP No 6139 Compact Driver's Night Viewer

Development/Description

The EL-OP No 6139 compact driver's night viewer is a bi-ocular passive electro-optical vision device designed for closed hatch driving of armoured vehicles at night. Using fixed focus and diopter systems it electro-optically intensifies the available ambient light to enable the vehicle driver to drive at low light levels without the use of any additional active illumination sources.

The light from the scene being observed is deflected by the head prism of the viewer into the vertically mounted image tube. An image of the scene is formed on the tube output screen in an amplified brightness state. The image is then redirected to an upright position by the lowerfold prism of the eyepiece subassembly and displayed to the viewer by the bi-ocular lens as



EL-OP No 6139 compact driver's night viewer from front

a simulated double-eyed observation of the scene. This lens type allows the driver to observe the scene with both eyes at a convenient distance from the instrument whilst remaining seated in the normal driving position. The viewer rotates laterally to the left and right with an indexing detent indicating the forward driving direction.

The system comprises the following parts:

1) the upper prism, which is the part of the device that protrudes above the driver's hatch plate and observes the view in front. It folds the optical path into the vertically placed input objective where the objective assembly forms the image of the scenery on the faceplate of the image intensifier tube. This, together with its operational electronics, forms part of the main housing assembly. The upper prism forms the amplified brightness secondary image on its output screen which is presented to the driver by the bi-ocular assembly at the required magnification and apparent distance

2) the bearing block, which permits the horizontal traverse of the viewer as well as serving as the mounting fixture in the tank

3) a connected shield, to ensure maximum protection of the upper prism from accidental damage

4) a power cable to connect the viewer to the vehicle power supply.

The viewer is easily installed in a large variety of AFV models and is offered as an optional extra in the EL-OP BAT-30 Computerised Tank Fire-Control System (qv).

SPECIFICATIONS

LENGTH (including handle) 360 mm WIDTH 152 mm DEPTH 185 mm WEIGHT 7 kg FIELD-OF-VIEW 35° horizontal and vertical TRAVERSE ADJUSTMENT +30

TOTAL FIELD-OF-VIEW (transversed)

FOCUS SETTING RESOLUTION

MAGNIFICATION DISTORTION

VEHICLE POWER SUPPLY EMERGENCY POWER SUPPLY 65° from 15 m to infinity

fixed

1.5 lp/mrad at 10-4 fl (background

illumination)

x 1 measured at 50 mm eye relief 5% max

24 ± 6 V DC through electronic regulator

2 × 1.5 V flashlight batteries with automatic

relay to switch from vehicle to emergency power supply upon external power failure

Status: In production. In service with Israel and other unspecified countries.

Manufacturer: EL-OP Electro-Optics Industries Limited, Advanced Technology Park, Kiryat Weizmann, POB 1165, IL-76110 Rehovot, Israel. Telephone: (08) 386221 Telex: 381344 Fax: (08) 386237

ITALY

Alenia P192 Night Driving Periscope

Development/Description

The P192 is designed to be fitted on various types of armoured vehicle including the FIAT 6616, VCC 1, Marder 1, M41, M47, M48, M60, Leopard 1

It consists of a head prism, S 25 microchannel light intensifier tube and a bi-ocular eyepiece assembly. The light intensifier is fitted with a gain control that automatically cuts out when the photocathode illumination level becomes too high.

A filter allows observations to be made within the luminance range of 10-3 lux to 104 lux.

The bi-ocular arrangement enables the driver to view the scene with both eyes through the single large diameter eyepiece and allows him to drive the vehicle at speeds of up to 40 km/h in starlight conditions without any artificial illumination.

SPECIFICATIONS

WEIGHT 7 kg MAGNIFICATION $\times 0.9$ FIELD-OF-VIEW 48 horizontal 409

Status: Production. In service with unspecified countries.

Manufacturer: Alenia, Avionic Systems and Equipment Group, I-20014

Nerviano, Italy

Telephone: (0331) 587330 Telex: 330675 AITNER



P192 Night Driving Periscopes showing different head arrangements

MES VG/DIL 186 Day and Night Driver Scope System

Development/Description

The VG/DIL 186 driver scope system has been designed to satisfy the technical and operational requirements required to drive an armoured fighting vehicle in both day and night conditions.

The available models are the VG/DIL 186-C1 for the IVECO FIAT/OTO Melara C1 Ariete MBT and the VG/DIL 186-B1 for the IVECO FIAT/OTO Melara B1 (8 × 8) tank destroyer.

The driver scopes consist of the following modules:

a) binocular VO/IL 186 passive night vision goggles which use two, second-generation, 18 mm, microchannel, wafer type, image intensifier tubes that have automatic brightness control and bright source protection

b) type MES 82/1 or M17/1 daylight lposcope

c) goggles and Iposcope interface.

This arrangement allows the vehicle to be driven in the following ways:

i) at night with the hatch closed and the goggles and interface unit installed on the lposcope

ii) at night with the hatch open and the driver wearing the goggles only

iii) during the day with the hatch closed and the driver using the lposcope

Status: Production. In service with the Italian Army.

Manufacturer: Meccania per l'Elettronica e Servomeccanismi SpA (MES), Via di Vannina 78, I-00156 Rome, Italy.

Telephone: (06) 4123441/2/3/4/5

Telex: 611308 MESRO I Fax: (06) 4101792

SPECIFICATIONS Type MAGNIFICATION WEIGHT	VG/DIL 186-B1 × 1 5.0 kg	VG/DIL 186-C1 × 1 4.5 kg	VO/IL 186 × 1 0.9 kg	Type RESOLUTION (USAF target 90% contrast)	VG/DIL 186-B1	VG/DIL 186-C1	VO/IL 186
FIELD-OF-VIEW				10 ⁻³ lux	3.2 mils	3 mils	3 mils
horizontal	38°	380	38♥	10 ⁻² lux	2.2 mils	2 mils	2 mils
vertical	30°	35°	30°	10-1 lux	1.7 mils	1.5 mils	1.5 mils
DIOPTER RANGE FOCUS RANGE	-6 to +2 25 cm to infinity	-6 to +2	_	POWER SUPPLY	2.2 to 3 V DC	2.2 to 3 V DC	2.7 V battery

NETHERLANDS

SIGNAAL Usfa UA9630 Driver's Universal **Passive Periscope Series**

Development/Description

The UA9630 Universal Passive Periscope series has been designed to allow armoured fighting vehicles to be driven at night without artificial aids. The periscope has also been fitted with a manually operated iris-diaphragm so as to adjust the image brightness and allow operations at the high illumination levels which are found during daytime.

Automatic brightness control is incorporated with a device to provide highlight suppression when a bright light source is unmasked. The system automatically reverts to normal use afterwards.

The binocular viewing system contains two Philips Type XX1080 NATO standard image intensifier tubes.

The periscope itself comprises a Type UA 1624 main instrument with a top prism unit that is tailored to the vehicle type in which it is fitted.

Available prism models include:

- 1) UA1752:Leopard 1 MBT and Marder 1 ICV
- 2) UA1755:M113 APC, M41 light tank and M47 MBT
- 3) UA1757:AMX-13 light tank
- 4) UA1763:M48 and M60 MBTs
- 5) UA1771:Scorpion armoured vehicle family and FV432 APC series
- 6) UA1773:Armored Infantry Fighting Vehicle (AIFV)
- 7) UA1776:Leopard 2 MBT

SPECIFICATIONS

WEIGHTS main instrument

approx 6 kg

top prism

1.5-6 kg depending upon vehicle type $\times 0.9$

MAGNIFICATION

FIELD-OF-VIEW

50

horizontal vertical

40°

RANGE

5 m to infinity

POWER SUPPLY

24 V DC vehicle system

Status: Production. In service with several unspecified countries.

Manufacturer: SIGNAAL USFA, Meerenakkerweg 1, NL-5600 HA

Eindhoven, Netherlands

Telephone: +31 40 503 603 Telex: 51732 USFAE NL

Fax: +31 40 503 777



SIGNAAL Usfa UA9630 driver's passive vision periscope from rear as fitted to Leopard 1 MBT

Oldelft Type PG1MS Night Vision Goggles

Development/Description

The Oldelft Type PG1MS night vision goggles have been developed for use by drivers of AFVs and are a typical second-generation night vision system



Oldelft Type PG1MS night vision goggles

with two image intensifier tubes, focus stable objective lens and adjustable

The goggles are held in place by head straps. A snap-on infra-red light source gives additional illumination for map or document reading.

SPECIFICATIONS

WEIGHT about 1 kg DIMENSIONS 120 × 138 × 90 mm MAGNIFICATION $\times 0.9$

FIELD-OF-VIEW (min) 40

RANGE typically up to 150 m FOCUS RANGE 300 mm up to infinity 1 × NiCad or dry cell AA BATTERY

Status: In production. In service with a number of NATO and other unspecified armies.

Manufacturer: Oldelft, PO Box 72, NL-2600 MD Delft, Netherlands. Telephone: (15) 601 901 Telex: 38345 Fax: (15) 145 762

Oldelft Type PC1MC Cyclop Night Vision Goggles

Development/Description

The PC1MC Night Vision Goggles are known as Cyclop because they incorporate a single second-generation image intensifier tube into their make-up. They are lightweight and the near-face position of the centre of gravity makes them easy to wear even with a helmet on for such tasks as vehicle night driving or maintenance.

SPECIFICATIONS

WEIGHT

600 g

DIMENSIONS MAGNIFICATION 170 × 131 × 82 mm \times 1

FIELD-OF-VIEW

40°

BATTERY $2\times NiCad$ or dry cell AA or $1\times lithium$ cell

AA

Manufacturer: Oldelft, PO Box 72, NL-2600 MD Delft, Netherlands. Telephone: (15) 601 901 Telex: 38345 Fax: (15) 145 762



Oldelft Type PC1MC night vision goggles

Oldelft Lightweight Universal Night Observation System (LUNOS)

Development/Description

The LUNOS passive night vision family consists of a single body, which is standard for all applications, several objectives with various magnifications (x 1, x 4 and x 6) and a number of optional mountings such as mask, grip, monopod and reticle.

The LUNOS 1 mask assembly can be used as a passive night vision goggle set for vehicle driving or other night time duties such as vehicle

The system can be fitted with second- or third-generation image intensifier

SPECIFICATIONS (LUNOS 1 system)

WEIGHT

with face mask

approx 820 g

without face mask DIMENSIONS

570 g

MAGNIFICATION

160 × 72 × 131 mm

FIELD-OF-VIEW

 $\times 1$ 40°

OBJECTIVE

f/1.1

Status: Production.

The complete Oldelft LUNOS family of night observation devices with LUNOS 1 fourth from left, front row

Manufacturer: Oldelft, PO Box 72, NL-2600 MD Delft, Netherlands. Telephone: (15) 60 19 01 Telex: 38011 Fax: (15) 14 57 62

NORWAY

SIMRAD GN1 Night Vision Goggles

Development/Description

The GN1 passive night vision goggles which can be used for vehicle driving and maintenance tasks, use a unique patented design incorporating a folded optical path. This results in an extremely compact and light goggle system which is either worn with a lightweight face mask or clipped onto a helmet for vehicle driving or other duties performed at night.

An optional add-on prism assembly provides dual vision capability. The GN1 is simple to operate having only a three-position ON/OFF/IR switch, focus control and diopter setting. An integral IR diode provides extra illumination for map or document reading.

The GN1 is designed to use either a second-generation 18 mm wafer high performance inverting with glass input, or third-generation 18 mm wafer image intensifier tube of the ANVIS type.

SPECIFICATIONS

390 g WEIGHT **DIMENSIONS** 58 × 155 × 73 mm MAGNIFICATION $\times 1$ RESOLUTION 1.5 mrad DIOPTER RANGE -6 to +2 FIELD-OF-VIEW 40° FOCUS RANGE 20 cm to infinity **OBJECTIVE** f/1 > 25 000 GAIN BATTERY 2 × 1.5 V AA



SIMRAD GN1 night vision system in use

Status: Production. In service with Norwegian and Swedish Armies.

Manufacturer: SIMRAD Optronics A/S, PO Box 6614 Etterstad, N-0602 Oslo 6, Norway

Telephone: 47 2 67 04 90 Telex: 76134 SIM N Fax: 47 2 19 29 91

PAKISTAN

Institute of Optronics AN/PVS-5A Night Vision Goggles

Development/Description

The Institute of Optronics AN/PVS-5A night vision goggles are a locally built variant of the standard US Army AN/PVS-5A night vision goggle system for general-purpose work in the visible and infra-red spectral regions (up to 0.86 microns) including vehicle driving.

The goggles incorporate two second-generation, 18 mm, microchannel, wafer type, image intensifier tubes which allow the user to view at ranges from 250 mm up to infinity. A self-contained infra-red illuminator source is used for map reading and equipment maintenance.

SPECIFICATIONS

850 g WEIGHT

DIMENSIONS 117 × 173 × 165 mm

MAGNIFICATION

BRIGHTNESS GAIN 2000 nominal RESOLUTION 27 lp/mrad DIOPTER RANGE +2 to -6 FIELD-OF-VIEW 40° BATTERY 2 × 1.5 V AA

FOCUS RANGE 25 cm to infinity **OBJECTIVE** 27 mm, f/1.0

Status: Production. In service with the Pakistani Army.



AN/PVS-5A night vision goggles

Manufacturer: Institute of Optronics, Ministry of Defence, PO Box 1596,

Chaklala-Rawalpindi, Pakistan.

Telephone: 590805/590806

POLAND

PEO Driver's Passive Night Vision Periscope

Development/Description

The PEO driver's passive night vision periscope is a small binocular wideangle viewing system for use in a variety of armoured vehicles including tanks and APCs. It provides the driver with a direct and constant bright vision level of the road or terrain in front of him under starlight conditions.

The periscope comprises two independent viewing channels - each comprising one objective lens system, one 18 mm single-stage second generation image intensifier tube and an eye-piece. The image intensifier tubes have automatic bright light protection and automatic gain control.

Status: Production as required. In service with Poland and other undisclosed

Manufacturer: PEO Warszawa, Industrial Centre of Optics, 75 Ostrobramaska St, PL-04-175 Warsaw, Poland.

Telephone: (48-22) 12-74-98 Telex: 81 3877 PCO-PL Fax: (48-22) 13-94-24

SPECIFICATIONS

POWER SUPPLY

DIMENSIONS (height × width) 282 × 150 mm

MAGNIFICATION FIELD-OF-VIEW 300

18 - 30 V DC

PEO Driver's Night Vision Goggles

Development/Description

The PEO night vision goggles are a small dimensioned lightweight passive vision system based on the use of single stage image intensifier tubes with fibreglass housing and high speed optics.

The goggles allow the user to undertake night-time tasks such as night driving of vehicles (including tanks), map reading, repairs and so on, without the need for illumination and with both hands free for the task itself.

The goggles can also be worn with an NBC mask or helmet. An auxiliary IR light source is fitted to aid short range tasks such as map reading.

SPECIFICATIONS

DIMENSIONS (height × length) approx 80 × 105 mm

 WEIGHT
 approx 1 kg

 MAGNIFICATION
 × 1

 FIELD-OF-VIEW
 min 40°

POWER SUPPLY 2 × 1.5 V AA batteries

Status: Production as required. In service with Poland and other undisclosed countries

Manufacturer: PEO Warszawa, Industrial Centre of Optics, 75 Ostrobramaska St, PL-04-175 Warsaw, Poland. Telephone: (48-22) 12-74-98 Telex: 81 3877 PCO-PL

Fax: (48-22) 13-94-24

SOUTH AFRICA

Eloptro ND-15 Night Driverscope

Development/Description

The Eloptro ND-15 passive vision night driverscope is a bi-ocular wideangle viewing night periscope utilising a second-generation image intensifier tube. The system allows vehicles to be driven during the hours of darkness at normal speed without artificial lighting.

The special fixed focus bi-ocular eyepiece allows simultaneous viewing with both eyes to provide ease of observation and free head movement for internal instrument viewing within the vehicle.

A fixed focus objective lens is used and adjustable gain setting of the intensifier tube provides brightness control for high light levels.

The head prism is easily removed and fits into the standard NATO driver's day periscope mount, making it adaptable to a wide variety of armoured vehicle types.

A horizontal manual scanning mechanism provides an additional 30° field-of-view in the horizontal plane. The instantaneous field-of-view in both the vertical and horizontal planes is about 40°.

SPECIFICATIONS

 $\begin{array}{lll} \text{WEIGHT} & 6.9 \text{ kg} \\ \text{LENGTH} & 220 \text{ mm} \\ \text{WIDTH} & 200 \text{ mm} \\ \text{HEIGHT} & 360 \text{ mm} \\ \text{MAGNIFICATION} & \times 0.92 \pm 0.05 \end{array}$

FIELD-OF-VIEW

horizontal 42 $\pm 2^{\circ}$ vertical 40 $\pm 2^{\circ}$

FOCUS fixed, 15 m to infinity

DIOPTER SETTING 2 ±0.5

POWER SUPPLY automatic switch over from 3 V internal to

vehicle supply

Status: Production as required. In service with the South African Defence Force.



Eloptro ND-15 night driverscope

Manufacturer: Eloptro (Pty) Ltd.

Enquiries to Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635

Eloptro ND-20 Night Driver's Periscope

Development/Description

The ND-20 night driver's persicope is a second generation passive image intensifier tube night viewing system for use by driver's of wheeled or tracked vehicles such as the Rooikat or MBTs. It can be fitted to most types of vehicles by means of an interface adaptor. An alternative battery power source capability is provided for by an auto-switching device.

The bi-ocular eyepiece enables viewing with both eyes simultaneously whilst allowing free head movement. Eyepiece inclination options available are 0° and 15°.

A manual scanning capability provides an additional 30° to the field-ofview in the horizontal plane. The head prism is made for easy removal to ensure rapid operational replacement.

SPECIFICATIONS

WEIGHT 12 kg
DIMENSIONS 420 × 320 × 390 mm
FIELD-OF-VIEW

horizontal 44.5°
vertical 44.5°
HORIZONTAL SCANNING 30°
DIOPTER RANGE fixed at -2
FOCUS fixed

DEPTH OF FIELD 15 m to infinity POWER SUPPLY 20 – 30 V DC,

20 – 30 V DC, autoswitching to C type dry cells or NiCad batteries, 3V DC



Status: Production as required. In service with South African Defence Forces

Manufacturer: Eloptro (Pty) Ltd.

Enquiries to Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635

Eloptro ND-20 night driver's periscope from the driver's side

SPAIN

ENOSA PCN Night Driving Periscope Series

Development/Description

The PCN series of night driving periscopes are supplied according to the type of head (prism, swivel or tilting model) required by the type of armoured vehicle to be fitted.

The current family members are:

- a) PCN-151 with internal azimuthal swivel mounting for use on the BMR-600 IFV
- b) PCN-152 which can be used to replace the M24 periscope on the M48 series MBT
- c) PCN-153 which is used to replace the M19 periscope on the Spanish Army M113 TOA APC
- d) PCN-154 which can be used to replace the OB 31A periscope on the AMX-30E MBT

All are fitted with a second-generation, 25 mm, image intensifier tube with automatic and manual gain controls.

The driver views through a bi-ocular type screen which is fitted with an electro-optical protection system to prevent the illumination level becoming too high.

SPECIFICATIONS

DIMENSIONS PCN-151 155 × 140 × 410 mm PCN-152 155 × 200 × 410 mm PCN-153 155 × 200 × 396 mm PCN-154 155 × 193 × 410 mm

MAGNIFICATION $\times 1$

FIELD-OF-VIEW

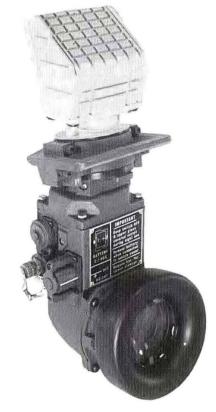
horizontal 440 vertical 359 RESOLUTION 1.25 mrad DEPTH OF FOCUS 4 m to infinity

IMAGE INTENSIFIER TUBE 25 mm second-generation

POWER SUPPLY 24 V DC

EMERGENCY POWER SUPPLY 1 × 2.7 V BA1567/U battery

Status: PCN-151 to 154 production as required. In service with the Spanish



PCN-151 driver's periscope from rear

Manufacturer: Empresa Nacional de Optica SA (ENOSA), Polígono Industrial 'La Mina' (P.11), E-28770 Colmenar Vieja (Madrid), Spain. Telephone: (91) 846 0100 Fax: (91) 846 0102

ENOSA AMX-30E MBT Driver's Periscopes

Development/Description

As part of the technology transfer associated with the local production of the French AMX-30E MBT variant, ENOSA is producing the following driver's periscope systems under licence:

a) the M-223 general observation day periscopes with NBC protection three of which are used by the driver for forward viewing, two by the loader and one by the gunner.

SPECIFICATIONS

vertical

5.47 kg WEIGHT PERISCOPE HEIGHT 170 mm CLAMPING HOLE **MEASUREMENTS** 170 × 170 mm MAGNIFICATION FIELD-OF-VIEW horizontal

1700 mils 500 mils

b) a TRT OB-31A (qv) night-driving periscope which replaces the centre one of the three M-223 general observation day periscopes.

SPECIFICATIONS

WEIGHT 7.85 kg

DIMENSIONS $163 \times 193 \times 327 \text{ mm}$

PERISCOPE HEIGHT 220 mm MAGNIFICATION × 0.95

FIELD-OF-VIEW

horizontal 48° vertical 40° POWER SUPPLY 24 V DC

 ${\bf Status:}\ {\bf M}\text{-}223$ and OB-31-A in production. In service with the Spanish Army (on AMX-30E MBT).

Manufacturer: Empresa Nacional de Optica SA (ENOSA), Polígono Industrial 'La Mina' (P.11), E-28770 Colmenar Vieja (Madrid), Spain.

Telephone: (91) 846 0100 Fax: (91) 846 0102

SWITZERLAND

Leica NAP5 Night Driving Periscope

Development/Description

The NAP5 night driving periscope is available for use on different armoured vehicle types simply by changing the vehicle adapter and head prism. Known designations include the NAP5-1 for use on the Pz 68 MBT and the NAP5-3 for use on the M113 APC and the MOWAG Piranha wheeled AFV.

The periscope is used for driving the armoured vehicle in ambient moonlight, starlight and/or skyglow conditions. This residual night light is transmitted via the prism and an objective to a second-generation image intensifier tube which produces the image of the area being observed for the driver's –1 fixed diopter setting, bi-ocular viewing system.

If a bright light source suddenly appears the image intensification is automatically reduced to avoid the driver being dazzled.

The periscope is powered from the vehicle's 24 V DC supply with automatic changeover to an internal battery if the main supply is interrupted for any reason.

SPECIFICATIONS

WEIGHT (basic unit) 4.5 kg

DIMENSIONS (basic unit) 140 × 170 × 247 mm

MAGNIFICATION \times 0.95 TRAVERSE RANGE \pm 30°

FIELD-OF-VIEW horizontal 40°

vertical 30°

IMAGE INTENSIFIER second-generation 20/30

 RESOLUTION
 1.3 mrad/lp

 OBJECTIVE
 f/1.3

 DEPTH OF FOCUS
 4 m to infinity

 POWER SUPPLY
 24 V DC

 EMERGENCY POWER SUPPLY
 1 × 2.7 V lithium cell

Status: Production. In service with several undisclosed countries.

Manufacturer: Leica AG, Special Products Division, CH-9435 Heerbrugg,

Switzerland.

Telephone: +41 71 70 31 31 Telex: 881 222 31 wi ch

Fax: +41 71 72 18 65



Leica NAP5 night driving periscope in MOWAG (6 × 6) Piranha AFV from driver's side

UNITED KINGDOM

GEC Sensors SS130 Passive Night Driving Periscope

Development/Description

The SS130 night driving periscope has been developed to fit into many armoured vehicles in service with the UK and other armed forces and can also be adapted to view through the windscreen of conventional vehicles such as Land Rovers.

It comprises an objective channel tube with a microchannel image intensifier tube and a bi-ocular fixed-focus eyepiece. The latter enables the driver to use both eyes for driving. A thermostatically controlled heater is also fitted.

The provision of an iris diaphragm allows the emergency use of the sight during daylight hours. Power is provided through the vehicle supply although a trickle-charged battery is fitted within the sight for back-up purposes.

SPECIFICATIONS

DIMENSIONS 235 \times 175 \times 340 mm WEIGHT 7 kg

MAGNIFICATION × 1
FIELD-OF-VIEW
horizontal 48.7°

vertical 40°

POWER SUPPLY 24 V DC vehicle system PERFORMANCE

 detection
 1100 m

 recognition
 275 m

 identification
 130 m

Status: Production. In service with the British Army and other countries.

Manufacturer: GEC Sensors, Electro-Optical Military Division, Christopher Martin Road, Basildon, Essex, SS14 3EL, UK.

Telephone: (0268) 522822 Telex: 99225 Fax: (0268) 883140

Pilkington Optronics Passive Night Vision Driving Periscope

Development/Description

This passive night vision driving periscope is designed to be interchangeable with the existing day periscopes of the following vehicle types without modification: Leopard 1 MBT, Chieftain (ARV, ARRV and MBT), Scorpion, Scimitar, Striker, Spartan, Samson, Samaritan, FV430 series, M107, M109, M110, M113 APC series and M60 MBT series. With some modifications it can also fit the AMX-30 MBT and the Panhard AML armoured car.

Assembly is effected by special vehicle mounting brackets and upper casings.

The periscope incorporates a Mullard second-generation single microchannel plate image intensifier tube to provide the high gain necessary to achieve good contrast imagery, especially in low-light conditions.

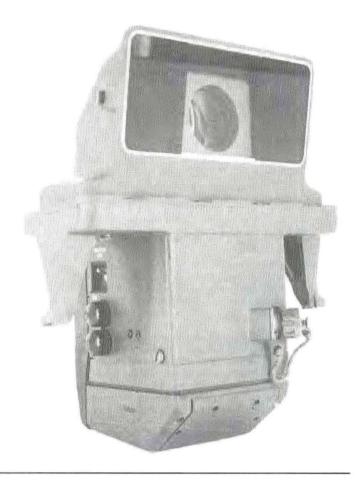
The optical assembly includes a bi-ocular eyepiece to provide operator comfort when in use. An iris control is incorporated allowing the operator to manually set the desired image brightness, whilst an automatic brightness control restricts the effects of bright light sources such as flares, shell bursts and headlights in the field-of-view.

Weight complete varies from 6-10 kg according to the vehicle type being fitted. Magnification is × 1 with 50° horizontal and 40° vertical fields-of-view. Power requirement is the normal vehicle 28 V DC system.

Status: In production. In service with the British Army and several unspecified countries.

Manufacturer: Pilkington PE Ltd, Glascoed Road, St Asaph, Clwyd LL17 OLL, UK.

Telephone: (0745) 588000 Telex: 61430 Fax: (0745) 584258



Pilkington Optronics passive night driver's periscope from the front

Pilkington Optronics Nova General-purpose Night Vision Goggles

Development/Description

The Nova night vision goggles are designed for general-purpose use including vehicle driving. They can be head-mounted and utilise a single, 18 mm, non-inverting microchannel plate proximity focussed second-generation image intensifier tube with a binocular eye configuration to provide user comfort.

Power is supplied by a single internal 2.7 V battery (mercury or lithium) which can easily be replaced by the user. The battery provides sufficient power for up to 66 hours of continuous operation.

It has only three controls: an on/off switch, focus control and eyepiece adjustment.

An integral infra-red diode provides extra illumination to assist in the performing of close order tasks such as map reading.

Weight is 0.675 kg complete, magnification is \times 1 and the field-of-view is 40° with the range on a man-sized target under 10° lux conditions being 300 m. The goggles can view at ranges from 300 mm to infinity by means of a focus adjustment. Dimensions are 190 \times 90 \times 100 mm.

It is compatible with NBC clothing and was designed specifically for use with a respirator.

Status: In production. In service with the British Army and a number of unspecified countries.

Manufacturer: Pilkington PE Ltd, Glascoed Road, St Asaph, Clwyd LL17 0LL, UK.

Telephone: (0745) 588000 Telex: 61430 Fax: (0745) 584258



Pilkington Optronics Nova general-purpose night vision goggles

UNITED STATES OF AMERICA

Baird AN/VVS-2 and NDS-2 Passive Driver's Night Vision Viewer

Development/Description

The Baird AN/VVS-2 was initially developed for use on the M60 MBT family but is now used in the M1 Abrams under the designation AN/VVS-2(V)2A, M60A3 AN/VVS-2(V)1A version and the M2/M3 Bradley vehicles as the AN/VVS-2(V)3.

It uses a second-generation image intensifier tube system which provides protection from bright lights, as well as shell bursts and flares, but relies on objects to be illuminated by low light levels from the natural moonlight, starlight and sky glow.

For other US AFVs such as the M47, M48 and M60A1 MBTs, the M113 APC and the AAV7 families, the NDS-2 Model 1924 has been developed as a private venture. This is an exact replacement for the M19 and M24 active infra-red viewers. No vehicle modifications are required and the installation can be performed in the field if necessary. Any vehicle that uses the NDS-2 mount is also field-retrofitted with a modified tank hatch insert that will accept the internal azimuth rotation mount. The NDS-2 provides a rotatable 45° field-of-view and incorporates a similar second-generation image intensifier tube.



The AN/VVS-2 consists of an objective lens assembly, a bi-ocular eyepiece assembly, an entrance window housing assembly, a main housing assembly (which includes an electronic power control and an electric power adaptor), the low light level image intensifier tube and a mount assembly. It provides the same night vision capabilities to the driver as the M32E1 and M35E1 gunner's night vision periscopes and the M36E1 commander's night vision periscope systems.

SPECIFICATIONS

FIELD-OF-VIEW $45^{\circ} \times 38^{\circ}$ TOTAL COVERAGE 135° horizontal 38° vertical

FOCUS 4 m to infinity RESOLUTION 1.2 mils MAGNIFICATION $\times 1$ DISTORTION less than 4%

POWER SUPPLY 24 V DC vehicle

Status: In production. AN/VVS-2 series is in service with the US Army while NDS-2 is known to be in service with Israel and other unspecified countries. For the Canadian Armed Forces Baird has produced the AN/ VVS-501 which is used with the Leopard 1 and AVGP (6 × 6) vehicles. There is a separate entry for the AN/VVS-501 in this section.

Manufacturer: Baird Corporation, Optical Systems Division, 125 Middlesex Turnpike, Bedford, Massachusetts 07130, USA

Telephone: (617) 276 6166 Telex: 6817 303 Fax: (617) 276 6510

Baird NDS-2 Model 1924 driver's passive night periscope

Baird AN/VVS-501 Passive Night Driving Viewer

Development/Description

The AN/VVS-501 was developed for use by the Canadian Armed Forces on the Leopard 1 MBT and the Armoured Vehicle General Purpose family of wheeled vehicles. On the former it replaces the day vision blocks of the commander's and driver's stations whilst on the latter it replaces the identical day vision block of the driver's station. When not in use it is kept in a purpose built stowage case. Other fits include the Leopard 2 MBT.

The bi-ocular eyepiece assembly is identical to that used on the US Army's AN/VVS-2 system (qv). The night vision capability is provided by a single, second-generation, 25 mm, microchannel, image intensifier tube with automatic gain control and bright source protection.

Magnification is × 1 with a 45° horizontal and 38° vertical field-of-view.

Status: Production. In service with the Canadian Armed Forces (on AVGP vehicles and the Leopard 1 MBT) and other unspecified countries.

Manufacturer: Baird Corporation, Optical Systems Division, 125 Middlesex Turnpike, Bedford, Massachusetts 01730, USA

Telephone: (617) 276 6166 Telex: 6817 303 Fax: (617) 276 6150

Baird AN/VVS-501 passive night driving viewer from driver's side

Baird GP/NVG-1 Night Vision Goggles

Development/Description

The Baird GP/NVG-1 night vision goggles are designed for general-purpose use including vehicle driving. They can be head-mounted and utilise a single Litton 18 mm microchannel image intensifier tube with a very large aperture lens to gather the maximum amount of light. The rest of the optical chain consists of a collimator lens to gather the output of the image intensifier tube, mirrors to split this in half, and image lens and corner mirrors to carry the image to each eyepiece.

Power is supplied by a single internal 2.8 V battery. An LED is fitted to provide extra illumination for the performance of close order tasks such as map reading.

Weight is 0.643 kg complete, magnification is x 1 and the field-of-view is 40°. The goggles can view from 250 mm to infinity by means of a focus

Status: In production. In service with unspecified countries.

Manufacturer: Baird Corporation, Optical Systems Division, 125 Middlesex Turnpike, Bedford, Massachusetts 01730, USA

Telephone: (617) 276 6166 Telex: 6817303 Fax: (617) 276 6150



Fraser-Volpe M19A1 Driver's Night Periscope

Development/Description

The M19A1 periscope sight was designed for night driving on vehicles equipped with infra-red driving lights or spotlights. The reflected rays are picked up by the periscope which uses an image converter tube to change them to visible light images that are viewed through the two eyepieces.

The unit consists of two main components:

 head assembly which projects through the body armour of the vehicle and contains the prism that directs the reflected infra-red rays down to the lower periscope area

body assembly which contains the objective lens and image converter for the reflected rays. The M19A1 is widely used in the US Army and has been adapted to a wide variety of vehicle types including MBTs and the M113 APC.

Weight including the head assembly is 6.35 kg with the magnification being \times 1.

Status: Production as required. In service with the US Army and many other countries.

Manufacturer: Fraser-Volpe Corporation, 1025 Thomas Drive, Warminster, Pennsylvania 18974, USA.

Telephone: (215) 443 5240 Fax: (215) 443 0966

Hughes AN/VAS-3 Driver's Thermal Viewer

Development/Description

The AN/VAS-3 periscope-based driver's thermal imaging system is currently under evaluation by the US Army for use in the M1 Abrams MBT, M2/M3 Bradley ICVs and other Combined Arms Team vehicles. The US Marine Corps is also considering a modular configuration of Driver's Thermal Viewer for its Light Armored Vehicles. The modular variant is designed to be installed in the driver's hatch of other vehicles such as the LAV-105, M1059A3 Smoke Generator Vehicle and GKN Warrior without modification to the vehicle's armour or driver station.

During Desert Storm operations the US Army combat tested nine AN/ VAS-3 systems on Bradley vehicle's assigned to the 24th Mechanised Infantry Division. They performed successfully both in their primary role and in secondary tasks such as assistance in target acquisition, vehicle safety and survivability.

The AN/VAS-3 operates in the 7.5 to 12 μm region of the spectrum and provides a TV-like view of the terrain ahead through darkness, battlefield smoke, fog and haze.

The Infra-Red (IR) energy entering through the IR optics of the sight is mechanically scanned to obtain a rectangular field-of-view. A 60-element DT-591A/UA array of split-Sterling, cryogenically cooled, mercury cadmium telluride detectors photoconductively transduce the scanned IR radiation into electrical signals. These are then multiplexed and processed in visible light by means of a CRT and presented into the driver's bi-ocular eyepiece viewer in real-time.

SPECIFICATIONS

 WEIGHT
 11.4 kg

 MAGNIFICATION
 × 1

 FIELD-OF-VIEW
 40°

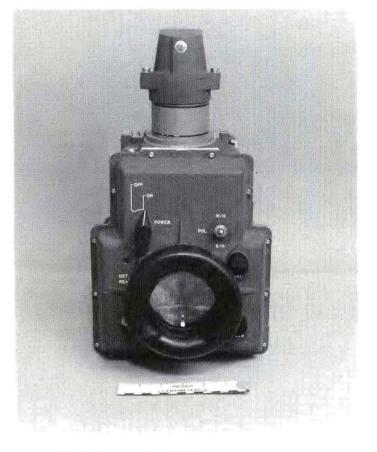
 azimuth
 40°

 elevation
 20°

Status: Evaluation phase. Three proof-of-design and 26 engineering development models have been delivered.

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems, PO Box 902, El Segundo, California 90245, USA.

Telephone: 310 616 1022 Telex: 3486 290



Hughes AN/VAS-3 Driver's Thermal Viewer

ITT Defense Improved AN/PVS-7B Gen III Passive Night Vision Goggles

Development/Description

The Improved AN/PVS-7B Gen III passive night vision goggles can be used for a wide range of night operations, including vehicle driving, in the visible to the near infra-red spectral region.

The improved goggles incorporate a new design for the objective lens, an MX-10130C Gen III image intensifier tube and eyepiece optical train. The objective lens improves the contrast performance whilst the new image intensifier tube and eyepiece optical train combine to improve the system resolution from 0.65 cycles/mrad to 0.76 cycles/mrad thereby increasing range performance.

Included in the goggles are:

- (a) a quick release lever that permits one-hand mounting and unmounting (b) an IR-on indicator for the built-in IR source that is used for map reading
- and maintenance tasks
- (c) an automatic high-light cut-off to protect the image intensifier
- (d) a low voltage indicator
- (e) a three position switch for OFF (all power off), ON (system on) and IR (system on plus IR on) settings.

Optional accessories include:

- (a) a C-mount adapter that allows the AN/PVS-7B body to accept any C-mount objective lens, thereby expanding the goggle's versatility
- (b) a tripod adapter that enables the goggles to be mounted on a wide variety of support hardware
- (c) a \times 3 magnification military objective lens in the C-mount configuration
- (d) a × 4.5 magnification military objective lens for extra long range viewing.



ITT Defense Improved AN/PVS-7B Gen III passive night vision goggles

SPECIFICATIONS

WEIGHT 680 g MAGNIFICATION × 1 **BRIGHTNESS GAIN** 2000 DIOPTER RANGE +2 to -6 RESOLUTION FIELD-OF-VIEW 40

IMAGE INTENSIFIER

one Gen III BATTERY

FOCUS RANGE

OBJECTIVE

.76 cycles/mrad

2 × AA or 1 × lithium or mercury (BA-5567)

25 cm to infinity

f/1.2

Status: Production. In service with unspecified countries.

Manufacturer: ITT Defense, Electro-Optical Products Division, 7635

Plantation Road, Roanoke, Virginia 24019, USA.

Telephone: (703) 563-0371

Night Vision Equipment Company NVEC 800/ **NVEC 800 HP Night Vision Goggles**

Development/Description

The NVEC 800 night vision goggles are designed to provide near-daylight vision capabilities at night. A choice of three mounting configurations is available, including a headstrap mounted version for night driving, close-up map reading and equipment repair. The NVEC 800 HP is the high performance version of the goggles fitted with ultrafast objective lens.

The goggles use a dual MX-9916 18 mm wafer type image intensifier tube assembly with a mask-mounted LED infra-red light source and detection system to enhance light levels for close-in work or see under totally dark situations. Automatic Brightness Control (ABC) and rapid recovery brightsource protection systems protect the tubes and maintain a constant image even when signal flares or muzzle flashes enter the field-of-view.

SPECIFICATIONS

WEIGHT 0.96 kg

DIMENSIONS MAGNIFICATION 171 × 171 × 120 mm

FIELD-OF-VIEW 40°

FOCUS RANGE

RANGE (man sized target quarter moon) DIOPTER RANGE **OBJECTIVE LENS**

IMAGE INTENSIFIER TUBE TUBE RESOLUTION

standard MIL-SPEC NVEC 800 high performance NVEC 800 HP

BATTERY SUPPLY

150 m +2 to -6

250 mm to infinity

f/1.09dual MX-9916

28 min-32 max Lp/mm

7000 min-15 000 max 18 000 min-22 000 max

2 AA alkaline or 1 BA1567/U military

Status: Production. In service with undisclosed countries.

Manufacturer: Night Vision Equipment Co Inc, PO Box 266, Emmaus,

Pennsylvania 18049, USA

Telephone: (215) 391 9101 Fax: (215) 391 9220

Litton M-912A/M-915A Night Vision Goggles

Development/Description

The M-912A/M-915A night vision goggles are based on the AN/PVS-5A design but incorporate an improved objective lens, have a higher gain and use brighter image intensifiers.



Litton M-912A/M-915A night vision goggles

The M-912A utilises two, second-generation, wafer type, image intensifier tube assemblies, each having an 18 mm image format, which give a brightness gain of 1000.

The M-915A utilises two 18 mm second-generation plus image intensifier assemblies which gives the system a brightness of 1700, some three times the value produced by the standard AN/PVS-5A.

Weight is 0.96 kg complete, magnification is x 1 and the field-of-view is 40° with the range on a 1.83 m target given as 230 m for the M-912A and 300 m for the M-915A.

SPECIFICATIONS

WEIGHT 960 g MAGNIFICATION \times 1 **BRIGHTNESS GAIN** M-912A 1000

M-915A 1700 RESOLUTION 0.68 lp/mrad FIELD-OF-VIEW 40°

BATTERY 2 × 1.5 V alkaline FOCUS RANGE 25 cm to infinity

OBJECTIVE

Status: Production as required. In December 1991 Litton Electron Devices Division was awarded a \$6.7 million contract by the US Army for 1200 M-915A night vision goggles.

Manufacturer: Litton Systems Inc, Electron Devices Division, 1215 South 52nd Street, Tempe, Arizona 85281-6987, USA.

Telex: 910-950 0149 Fax: (602) 966 9055 Telephone: (602) 968 4471

Litton M-972/M-973 Night Vision Goggles

Development/Description

The M-972A/M-973 night vision goggles are based on the AN/PVS-7. The single tube design provides a light weight capability that is designed for maximum flexibility in night vision applications which require high resolution, improved light amplification and higher output brightness than are normally available from standard second-generation tube assemblies.

The M-972 utilises an M870, non-inverting, second-generation plus, 18 mm, image intensifier assembly with a brightness gain of 1850, whereas the M-973 has an M871 non-inverting third-generation 18 mm, image intensifier tube with a gain of 2100.

If required, the 27 mm objective lens can be replaced by an optional × 4 magnification lens to convert the system into a hand-held night vision binocular.

Weight is 0.72 kg complete, magnification is × 1 and the field-of-view is 40° with the range on a 1.83 m target given as 250 m for the M-972 and 340 m for the M-973



SPECIFICATIONS

WEIGHT complete 720 g 680 g without AA batteries MAGNIFICATION BRIGHTNESS GAIN

M-972 1850 M-973 2100 RESOLUTION 0.76 lp/mrad

FIELD-OF-VIEW 40° BATTERY 1 × BA-1567/U mercury or BA-5567/U lithium

or 2 × AA NiCd or AA alkaline or BA-3058/U

alkaline

Status: Production. In service with unspecified countries.

Manufacturer: Litton Systems Inc, Electron Devices Division, 1215 South 52nd Street, Tempe, Arizona 85281-6987, USA.

Telephone: (602) 968 4471 Telex: 910-950 0149 Fax: (602) 966 9055

Litton M-972 night vision goggles, accessories and carrying case

Optic Electronic NV38 Driver's Viewer

Development/Description

The NV38 driver's viewer is a lightweight, self-contained, head-mounted, night vision system suitable for use by individual soldiers who have to perform vehicle driving or maintenance under night conditions.

It contains a third-generation image intensification tube which amplifies ambient illumination such as moonlight, starlight and sky glow. The other components are a single objective lens and a beam splitter/dual eyepiece assembly. The device is affixed to a face mask which is held in place on the user's head by adjustable head straps.

An infra-red emitting light source is incorporated which provides illumination when required.

The NV38 can also be provided with an improved second-generation image intensification tube assembly.

The viewer can be worn with the M1 (steel), DH-145 (Kevlar) and Combat Vehicle Crewman (CVC) helmet and with a protective mask for NBC use.

SPECIFICATIONS

WEIGHT INCLUDING

BATTERIES 0.765 kg MAGNIFICATION FIELD-OF-VIEW 400 GAIN (min) 500 ANGULAR RESOLUTION 1.5 mrad FOCUS RANGE 250 mm to infinity

BATTERY POWER 2 each AA size alkaline or one each

BA 5567/U or BA1567/U

EYEPIECE DIOPTER RANGE +2 to -6

OBJECTIVE f/1.2



Optic Electronic NV38 driver's viewer showing system and tube assemblies

Status: Production.

Manufacturer: Optic Electronic Corporation, 11545 Pagemill Road, Dallas,

Texas 75243, USA

Telephone: (214) 349 0190 Telex: 910 861 9312

Fax: (214) 343 7259

Optic Electronic NV43FL Driver's Night and Emergency Day/NBC Viewer

Development/Description

The NVL43FL has been designed as a driver's primary image intensified night vision viewer with a special daylight filtration system to allow continued use of the viewer when meeting sudden daytime combat or NBC conditions. This keeps the driver from having to remove the night sight and replace it with the formal daytime vision system. Continued long exposure of the second- or third-generation image intensifier tube used in the sight will, however, cause a shortened tube life so that the viewer must be turned off and secured as soon as conditions permit.

The NVL43FL consists of a 25 mm image intensified tube assembly with automatic gain control and bright source protection, objective lens, prism assembly, filtration unit and main housing. The last of these includes an electronic power control and electric power adapter. The filtration system is activated by a simple ON/OFF switch.

For back-up operations or station keeping observation, internal rechargeable NiCad batteries are fitted. The batteries are automatically connected into the power system if the primary vehicle power supply fails for any reason.

Under normal night-time operating conditions the driver is able to see objects illuminated by moonlight, starlight and sky glow.

SPECIFICATIONS

MAGNIFICATION $\times 1$ FIELD-OF-VIEW 45° horizontal vertical 350

min 25 000 GAIN IMAGE INTENSIFIER 25 mm GEN II (optional GEN III)

OBJECTIVE LENS f/1.09 RESOLUTION 1.25 mrad FOCUS RANGE 3 m to infinity

LINEAR DISTORTION less than 9% over entire range POWER SUPPLY 24 V ±6 V DC vehicle system BATTERY SUPPLY rechargeable NiCad batteries



Status: Production as required.

Manufacturer: Optic Electronic Corporation, 11545 Pagemill Road, Dallas, Texas 75243-0668, USA.

Telephone: (214) 349 0190 Telex: 910 861 9312 Fax: (214) 343 7259

NV43FL armoured vehicle driver's viewer with filter for daylight/NBC protection

Optic Electronic Driver's Night Viewers Family

The Optic Electronics range of driver's night viewers were developed for vehicle driving at night using second-generation image intensifier tubes. This allows the viewer to take the available light from moonlight, starlight and sky glow and intensify it to the point that objects can be viewed.

The available viewer models are given in the accompanying table together with the vehicle types to which they have or can be fitted.

Description

All family members contain a head prism, an electronic power control and adapter and are designed with a bi-ocular eyepiece for driver comfort. Power is supplied by the 24 V DC vehicle system with rechargeable NiCd internal batteries to provide automatic back-up if the primary supply should fail.

If required, the second-generation image intensifier tube can be exchanged for a third-generation system which provides an enhanced performance capability by virtue of the use of a high spectral response photocathode. This is some 10 times more sensitive than the second-generation system equivalent and, hence, can determine much more readily the difference in reflectivity of a man-made object versus the natural background.

Optic Electronic NV39Q passive driver's night viewer



NV43S

Scout

V-100

Osorio

Stingray

NV43X

AMX-13

AMX-30

/IEWER /EHICLE TYPE	NV39Q T-59 T-62 T-55 T-54A T-54	NV39S Scorpion	NV39T T-62 T-55	NV43 M41 M47 M109	NV43B TAM	NV43K Merkava	NV43L Leopard I Leopard 2 V-150 Centurion LAV-25	NV43M M60 M60A1 M48 M48A1 M48A2 M48A2C M48A3 M48A5 M41 M47 M113 AIFV AAV-7

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ANTEN MATERIA PROPERTY OF THE
O. C.

AN/VVS-2 NV-76

PT-76

M60A3

Bradley

NV43P Leonidas APC

Steyr APC

Panhard

SPECIFICATIONS	NV39Q	NV39T	NV43K	NV43L	NV43M	NV43P	NV43S	AN/VVS-2
MAGNIFICATION	× 1	× 1	× 1	× 1	× 1	× 1	× 1	×1
FIELD-OF-VIEW	X.I	× 1	* 1	× 1	* 1	× 1	× 1	× 1
horizontal	45°	45°	90°	90°	45°	45°	90°	90°
vertical	33°	33°	35°	35°	35°	35°	35°	35°
IMAGE INTENSIFIER	25 mm s	econd-generatio	n with automatic	gain control and	bright source p	rotection (option	al third-generation	n system)
OBJECTIVE LENS	f/1.4	f/1.2	f/1.09	f/1.09	f/1.69	f/1.04	f/1.4	f/1.09
FOCAL LENGTH	33.5 mm	33.5 mm	33.5 mm	33.5 mm	33.5 mm	33.5 mm	33.5 mm	33.5 mm
DEPTH OF FOCUS				4 m to	infinity			
BRIGHTNESS				variable-contr	rolled by driver			
TUBE GAIN	second-generation 25 000 (min)							
				third-generation	on 30 000 (min)			

BI-OCULAR MAGNIFIER POWER SUPPLY **EMERGENCY** POWER SUPPLY 45° fixed focus 18-30 V DC

NiCad rechargeable batteries

Status: Production as required. In service with a number of undisclosed

Manufacturer: Optic Electronic Corporation, 11545 Pagemill Road, PO Box 740668, Dallas, Texas 73574-0668, USA

Telephone: (214) 349 0190 Telex: 910 861 9312 Fax: (214) 343 7529

Varo Model 9876C (AN/PVS-5C) Night Vision Goggles

Development/Description

The Model 9876C (AN/PVS-5C) head-mounted night vision goggles are an improved version of the standard US Army AN/AVS-5A (qv) goggle system for general-purpose work including vehicle driving.

The goggles incorporate two, second-generation, 18 mm, MCP wafer, image intensifier tubes with a spectral response in the visual and infra-red region (to 0.86 μm).

The user can view at ranges from 254 mm up to infinity by means of a +2 to -2 diopter focus adjustment. A self-contained infra-red illuminator source is used for map reading and equipment maintenance.

SPECIFICATIONS

WEIGHT 0.96 kg MAGNIFICATION × 1 **BRIGHTNESS GAIN** 2000 nominal RESOLUTION 32 lp/mrad nominal

FIELD-OF-VIEW 40°

BATTERY 2 × 1.5 V AA or 1 × 3 V mercury/lithium

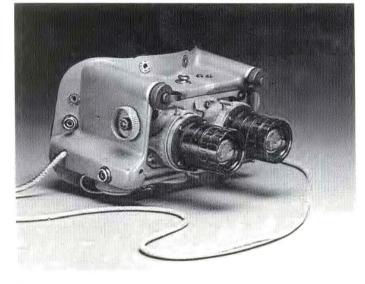
FOCUS RANGE 25.4 cm to infinity

OBJECTIVE f/1.05

Status: Production. In service with a number of undisclosed countries.

Manufacturer: Varo Electron Devices, 2203 West Walnut Street, PO Box 469014, Garland, Texas 75046-9014, USA.

Telephone: (214) 487 4100 Telex: 163165 VAROI UT Fax: (214) 487



Varo Model 9876C (AN/PVS-5C) night vision goggles

Varo Model 1500 (AN/PVS-7B) Night Vision Goggles

Development/Description

The Varo Model 1500 (AN/PVS-7B) passive night vision goggles can be used for a wide range of night operations including vehicle driving.

It is fitted with a second-generation image intensifier tube, and an optional ×3 magnification objective lens capability can be provided for hand-held observation.

For map reading or equipment maintenance a small infra-red illuminator source is provided with an eyepiece integrated on/off indicator.

SPECIFICATIONS

680 g WEIGHT (complete)

DIMENSIONS $152.4 \times 155.6 \times 101.6 \; mm$

MAGNIFICATION **BRIGHTNESS GAIN** 1850

RESOLUTION 0.81 lp/mrad (limiting)

FIELD-OF-VIEW 400 BATTERY 2 × 1.5 V AA or 1 × 3 V mercury/lithium

FOCUS RANGE 25 cm to infinity

M1 (steel), DH-145 (Kevlar) or Combat

Vehicle Crewman (CVC)

PROTECTIVE MASK

HELMET INTERFACE

CAPABILITY M17A2, M24, M25A1, XM40, XM41, XM42

and XM43

Status: Production. In service with a number of undisclosed countries.



Varo Model 1500 (AN/PVS-7B) night vision goggles

Manufacturer: Varo Electron Devices, 2203 West Walnut Street, PO Box 469014, Garland, Texas 75046-9014, USA.

Telephone: (214) 487 4100 Telex: 163165 VAROI UT Fax: (214) 487

YUGOSLAVIA (Serbia/Montenegro)

PPV-2 Passive Night Vision Periscope

Development/Description

The PPV-2 passive night vision periscope was designed for driving and general night observation use on the T-55 MBT, M-84 (license built T-72G) MBT, BVP M80A MICV, BVP M80AK IFV, M-60P APC and M-60PB antitank vehicle.

It uses an 18 mm second-generation light intensifier tube unit.

SPECIFICATIONS

 WEIGHT
 approx 6 kg

 DIMENSIONS
 300 × 168 × 139 mm

 MAGNIFICATION
 × 1

 FIELD-OF-VIEW
 34°

 DIOPTER RANGE
 -0.7 to +1

RESOLUTION POWER

 3×10^{-2} lux 2.2 mrad 1×10^{-3} lux 2.7 mrad 1×10^{-4} lux 5.0 mrad

IMAGE INTENSIFIER TUBE 18 mm second-generation

POWER SUPPLY 26 V DC

Status: Production. In service with Yugoslav Army.

Manufacturer: Enquiries to the contractor: SDPR – Federal Directorate of Supply and Procurement, PO Box 308, 9 Nemanjina Street, Belgrade 11105, Yugoslavia (Serbia/Montenegro).

Telephone: (011) 621 522 Telex: 11360/11541/11591 yu sdpr

Cable: DIRPROM Fax: +38 11 635 702

PN-2 Passive Night Vision Goggles

Development/Description

The PN-2 passive night vision goggles are a lightweight night viewing system for use by individual soldiers who have to perform such duties as vehicle driving and maintenance.

The system uses two single stage 18 mm image intensifier tubes of the second-generation type with focussable lens and adjustable eyepieces to achieve its results. It can also be used with an infra-red source to act as the illuminator for map or document reading.

When used the goggles are attached to the user's head by chin and head straps.

SPECIFICATIONS

 WEIGHT

 with mask
 1.1 kg

 without mask
 800 g

 MAGNIFICATION
 × 1

RESOLUTION 1 × 10⁻³ lux

 1 × 10⁻³ lux
 2.7 mrad

 DIOPTER RANGE
 -5 to +5

 FIELD-OF-VIEW
 34°

 POWER SUPPLY
 3 V (battery)

 FOCUS RANGE
 25 cm to infinity

Status: Production. In service with the Yugoslav Army.

Manufacturer: Enquiries to the contractor: SDPR – Federal Directorate of Supply and Procurement, PO Box 308, 9 Nemanjina Street, Belgrade 11105, Yugoslavia (Serbia/Montenegro).

Telephone: (011) 621 522 Telex: 11360/11541/11591 yu sdpr

Cable: DIRPROM Fax: +38 11 635 702.



Laser Rangefinders

CHINA, PEOPLE'S REPUBLIC

CEIEC Type 82 Tank Laser Rangefinder

Development/Description

The CEIEC Type 82 Nd-YAG 1.06 µm wavelength laser rangefinder consists of a main body assembly, a power and counter unit and connecting cables. It is suitable for use with the Type 59 and Type 69 series MBTs and can be adapted for other tank types after replacing the necessary components.

Combined with a sight or telescope system and coupled into a firecontrol system it can greatly increase the first-round hit probability.

The measured range is indicated by a three-decimal digital display on the display unit.

SPECIFICATIONS Unit MAIN BODY ASSEMBLY	Weight	Dimensions
(including base) POWER AND COUNTER UNIT RANGE ACCURACY	11.2 kg 3.1 kg 300-3000 m ±10 m	400 × 150 × 120 mm 173 × 113 × 149 mm



CEIEC Type 82 tank laser rangefinder with main body assembly on right and counter unit on left

Status: Production. In service with the Chinese Armed Forces.

Manufacturer: China National Electronics Import and Export Corporation (CEIEC), 49 Fuxing Road, Beijing, People's Republic of China.

Telephone: 810910 Telex: 22475 CEIEC CN

FRANCE

CILAS APX M550/TCV80 Laser Rangefinder

Development/Description

The TCV80 Nd-Glass 1.064 µm wavelength laser rangefinder is designed for use in the gunner's M504 sight on the AMX-10RC reconnaissance vehicle and the M554 sight on the AMX-30 B2 MBT. It may also be adapted for use with other types of fire-control systems for accurate target range measuring.

It comprises a single unit that houses the laser emitter, the receiver, power supply and electronic clock. The output is direct to the fire-control system ballistic computer.

SPECIFICATIONS

 DIMENSIONS
 260 × 110 × 160/110 mm

 WEIGHT
 3.5 kg

 LASER TYPE
 Nd-Glass

 WAVELENGTH
 1.064 μm

 OPERATING RANGE
 320-9995 m

 ACCURACY
 ±5 m

 OPERATING VOLTAGE
 19-28 V DC

Status: Production. In service with Cyprus, France, Morocco, Qatar and other unspecified countries.

Manufacturer: CILAS, Route de Nozay, F-91460 Marcoussis, France. Telephone: (1) 64 54 48 00 Telex: 601862 Fax: (1) 69 01 37 39

CILAS TCV107 Laser Rangefinder

Development/Description

The TCV107 Nd-YAG 1.064 μm wavelength laser rangefinder is designed for use on any type of tank or light armoured vehicle, either as an external installation in an armoured container, or inside, where it can be associated with an optical sight assembly.

It is modular in construction and consists of the following subsystems:

1) a sealed transmitter/receiver unit with an integral power circuit. A removable optical sight is used for aligning the system with the gun boresight axis by means of an integrated beam deviator

2) a control box for operating the equipment and displaying the results as a digital readout. A warning light indicates when there are several echoes and the distance of the furthest echo is automatically displayed. The range of the nearest one can then be obtained by pressing a button.

Known SOPELEM/Giat Industries sight/control systems to which the TCV107 can be fitted, include the following:

- a) SOPTAC 6 sight
- b) SOPTAC 10 fire-control system
- c) SOPTAC 11 fire-control system (used on French Gendarmerie and Omani VBC 90 armoured cars)

- d) SOPTAC 13 sight
- e) SOPTAC 18 fire-control system (AMX-13)
- f) SOPTAC 21 sight
- g) SOPTAC 22 fire-control system
- h) Giat Industries/SOPELEM/CILAS M586 day/night control system.

SPECIFICATIONS

DIMENSIONS OF

TRANSCEIVER 290 × 140 × 100 mm
WEIGHT OF TRANSCEIVER 6.3 kg

 LASER TYPE
 Nd-YAG

 WAVELENGTH
 1.064 µm

 OPERATING RANGE
 150-9500 m

 ACCURACY
 ±5 m

 OPERATING VOLTAGE
 19-29 V DC

Status: In production. In service with the French Gendarmerie (on SMS VBC 90 armoured cars). Oman (on SMS VBC 90 armoured cars), Venezuela, (on AMX-13 tanks) and several other unspecified countries.

Manufacturer: CILAS, Route de Nozay, F-91460 Marcoussis, France. Telephone: (1) 64 54 48 00 Telex: 601862 Fax: (1) 69 01 37 39

CILAS TCY901 Laser Rangefinder

Development/Description

The TCY901 laser rangefinder is intended as the replacement system for the TCV107. It is in service on Giat Industries 90 mm TS 90 and Lancelot III HOT turrets. It can also be independently fitted with its control box to many other turret models as a retrofit upgrade.

SPECIFICATIONS

WEIGHT 5 kg

DIMENSIONS 220 × 140 × 93.5 mm

LASER TYPE Nd-YAG WAVELENGTH 1.064 µm

Status: Production. In service with undisclosed countries.

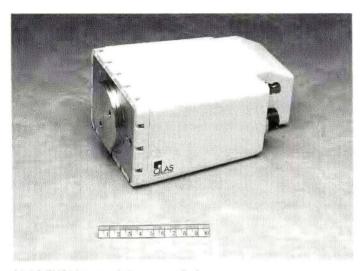
Manufacturer: CILAS, Route de Nozay, F-91460 Marcoussis, France. Telephone: (1) 64 54 48 00 Telex: 601862 Fax: (1) 69 01 37 39

CILAS TMS301 Eyesafe Laser Rangefinder

Development/Description

The TMS301 is part of a modular family of laser rangefinder devices that is designed for use without any constraints regarding ocular safety and with increased firing frequencies to allow for target mobility.

The main application of the TMS301 is as a rangefinder on tanks and helicopters, integrated into a fire-control system. At present the TMS301 optical and mechanical interfaces are compatible with those of the Leclerc MBT gunner's sight and the Viviane sight for the Aerospatiale Gazelle helicopter equipped with the Euromissile HOT ATGW system. If required, other specific sight interfaces can be adapted.



CILAS TMS301 eyesafe laser rangefinder

A 1.06 µm version, the TMY303, is available without the RAMAN conversion cell.

The TMS301 consists of four modules:

(a) a 1.54 µm transmitter module with a RAMAN effect conversion cell

- (b) an interface/control/range processing card with an ASIC circuit including eight programmable range finding windows
- (c) a very high sensitivity reception module (> 10 nW)

(d) a low voltage converter module.

These modules have been specifically developed to meet medium range/ medium rate laser rangefinding applications.

SPECIFICATIONS

DIMENSIONS 78.5 × 116 × 190 mm WEIGHT approx 3 kg

Transmitter module

WAVELENGTH 1.54 um PULSE RATE (2 versions) 1 Hz continuous

3 Hz continuous or 8 Hz for 5 s

Interface/control/range processing

RESOLUTION 30-8000 m RANGE LIMITS

LOGIC ECHO 8 programmable windows with

choice of first or last echo in each

window

RANGEFINDING WINDOW

2.5 m sten 300 m min range min width 50 m discrimination 30 m

Status: TMS301 development. TMY303 production is in service with undisclosed countries.

Manufacturer: CILAS, Route de Nozay, F-91460 Marcoussis, France.

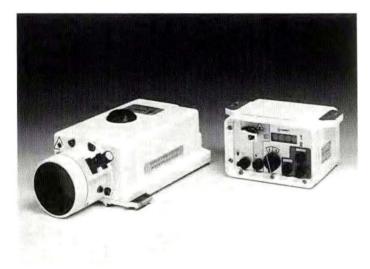
Telephone: (1) 64 54 48 00 Fax: (1) 69 01 37 39

SOPELEM ESTER 10 Laser Rangefinder for AFVs

Development/Description

The ESTER 10 laser rangefinder is a self-contained, waterproof unit containing an aiming channel with eye-safe erbium-glass laser technology. It is designed for integration into many kinds of turret and fire-control systems. It is either interfaced with its rangefinder control unit or a firecontrol system, as required.

Options include: a rotary prism alignment device; a line-of-sight alignment eyepiece or sight or projected graticule; and adaptable computer interface (current standard is TTL-compatible for laser signals).



SPECIFICATIONS

Laser rangefinder DIMENSIONS

WAVELENGTH

290 × 140 × 100 mm with dispersion meter 236 × 140 × 100 mm without dispersion meter POWER SUPPLY 20 - 32 V DC

LASER TYPE Erbium-glass with rotary prism

actuation 1.54 um

RANGE INFORMATION 1st and 2nd target RANGE LIMITS 160 - 9995 m

ACCURACY ±5 m RANGE DISCRIMINATION 30 m

Control Unit

DIMENSIONS 180 × 130 × 95 mm DISPLAY 4 digit type

INDICATION LIGHTS ready-to-fire, one target, multiple

targets

CONTROLS laser operation, lamp test, projected graticule SELECTOR 1st target, 2nd target

Status: Production as required.

Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimer Périer, PO Box

62, F-95872 BEZONS Cedex, France.

Telephone: (1) 34 23 30 00 Telex: 605793F Fax: (1) 34 23 33 50

SOPELEM ESTER 10 laser rangefinder for AFVs with rangefinder on left and control box on the right

SOPELEM TELAB Laser Rangefinder

Development/Description

The TELAB modular Nd-YAG laser rangefinder is a stand alone device (with its own aiming channel) that can be mounted on a wide variety of turrets or integrated into several types of fire-control systems. In the latter case it is either interfaced with its own command box or directly with the computer of the fire-control system.

Options include:

- (a) mechanical fitting by dovetail or fastening belts
- (b) rotative optical wedges device
- (c) viewing of the optical reception axis through an LED projected graticule
 - (d) viewing by eyepiece or boresighting sight
 - (e) customised computer interface (present standard is TTL compatible for laser signals).

SPECIFICATIONS

Transceiver box

DIMENSIONS

with optical wedges device without optical wedges device WEIGHT (with optical wedges device)

POWER SUPPLY LASER TYPE RANGE INFORMATION RANGE LIMITS ACCURACY

RANGE DISCRIMINATION

Control box

DIMENSIONS DISPLAY

INDICATOR LIGHTS

CONTROL BUTTONS

SELECTOR

Status: Production as required.

290 × 140 × 100 mm 236 × 140 × 100 mm approx 4 kg

20-32 V DC

Nd-YAG 1st and 2nd target 160-9995 m

±5 m 30 m

180 × 130 × 95 mm

4 digit type

ready-to-fire, one target, multiple

targets

firing, light tests, projected graticule intensity (optional), reset

1st target, 2nd target

SOPELEM TELAB laser rangefinder



Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimer Périer, PO Box

GERMANY

Eltro CE619 Laser Rangefinder

Development/Description

The CE619 Nd-YAG laser rangefinder is a multi-application system and can be used for other roles such as target illumination. In its ground role it can be interfaced with electro-optical fire-control systems and used as a redundant rangefinder for radar based anti-aircraft tracking units.

The subsystems comprising the CE619 consist of:

1) transceiver unit with built-in power supply circuits. The laser operates

using the pulse time-delay technique and can measure the ranges to both moving and fixed targets

2) electronics and control unit.

Status: Production.

Manufacturer: Eltro GmbH, Gesellschaft für Strahlungstechnik, Kurpfalzing 106, D-6900 Heidelberg 1, Federal Republic of Germany.

Telephone: (6621) 7050 Telex: 461811

Eltro CE624 Laser Rangefinder

Development/Description

The CE624 laser rangefinder, when used with gated viewing, is a combined MBT gunner's sight. The range to moving or fixed targets is continuously measured by a laser transmitter and a gated receiver using the pulse timedelay technique.

The range gating allows the observer to determine which target out of

several within view was measured by the laser pulse. Thus a selection of single targets and their ranges is provided.

Status: Production.

Manufacturer: Eltro GmbH, Gesellschaft für Strahlungstechnik, Kurpfalzing 106, D-6900 Heidelberg 1, Federal Republic of Germany. Telephone: (6621) 7050 Telex: 461811

Eltro CE628 Laser Rangefinder

Development/Description

The CE628 Nd-YAG laser rangefinder is integrated into the EMES 15 primary stabilised gunner's sight assembly of the Leopard 2 MBT and is capable of providing three accurate rangefinding values within four seconds.

The subsystems which comprise the CE628 include

- 1) laser transmitter/receiver unit
- 2) processing electronics unit with related power supply device.

Because of the sight assembly integration the gunner can at all times get an exact digital range read-out as the fire-control computer simultaneously processes the range data for use in the fire solution calculations

Status: Production.

Manufacturer: Eltro GmbH, Gesellschaft für Strahlungstechnik, Kurpfalzing 106, D-6900 Heidelberg 1, Federal Republic of Germany. Telephone: (6621) 7050 Telex: 461811

Eltro CE632 Laser Rangefinder

Development/Description

The CE632 laser rangefinder is designed to operate either as a separate unit or in conjunction with vehicle-integrated electro-optical fire-control systems.

It comprises two sub-units:

1) laser transmitter/receiver unit which operates according to the pulse time-delay method

2) display/control unit with built-in power supply The system is used on a number of German AFV types.

Status: Production. In service with the German Army.

Manufacturer: Eltro GmbH, Gesellschaft für Strahlungstechnik, Kurpfalzing 106, D-6900 Heidelberg 1, Federal Republic of Germany.

Telephone: (6621) 7050 Telex: 461811

Siemens Type LEM 3 Laser Rangefinder

Development/Description

The Type LEM 3 laser rangefinder was specifically developed for use against anti-aircraft targets and is incorporated into the fire-control system of the weapons platform. All the essential operating functions of the device are monitored by Built-In Test Equipment (BITE) facilities. The transmitter unit is air-cooled.

The Type LEM 3/1 model is fitted as standard to all German Army Gepard self-propelled gun systems.

SPECIFICATIONS

14 kg WEIGHT

DIMENSIONS 266 × 182 × 363 mm LASER TYPE Nd-YAG 1.06 um WAVELENGTH OPERATING RANGE 5000 m ACCURACY +2.5 m POWER SUPPLY vehicle system

Status: Production as required. In service with the German Army (Type LEM 3/1 on the Gepard self-propelled anti-aircraft vehicle)

Manufacturer: Siemens AG, PO Box 103, D-8000 Munich 1, Federal

Republic of Germany

Telephone: (89) 234 3408 Telex: 523 121



Siemens Type LEM 3/1 laser rangefinder

ISRAEL

EL-OP Mini-Laser Tank Rangefinder

Development/Description

The EL-OP mini-laser rangefinder is designed for integration into firecontrol system upgrades for tanks like the M41, M47, M48, M60, AMX-13, AMX-30. T-Series and the Centurion and, as such, it is also offered as part of the company's BAT-30 (qv) tank fire-control system.

It provides high accuracy range measurements using only two units, an electronics box and a 1.064 µm wavelength Nd-YAG laser sight and is fully compatible with the periscopes on the M32 and M36 sighting devices, replacing their existing day elbows.

SPECIFICATIONS

OPERATING RANGE 300 to 9990 m RANGE ACCURACY ±10 m RESOLUTION 30 m

× 8 magnification with 8° field-of-view SIGHT

WEIGHTS electronics control box 1.7 kg

rangefinder unit 4.5 kg

DIMENSIONS electronics control box

150 × 130 × 90 mm $310 \times 26 \times 10 \text{ mm}$ rangefinder unit POWER SUPPLY 24 V DC vehicle

Status: In production. In service with unspecified countries.

Manufacturer: EL-OP Electro-Optics Industries Ltd, Advanced Technology Park, Kiryat Weizmann, PO Box 1165, IL-76110 Rehovot, Israel. Telephone: (08) 386221 Telex: 381344 Fax: (08) 386237



EL-OP Mini-Laser Rangefinder which also forms a key part of EL-OP BAT-30 tank fire-control system

EL-OP Tank Laser Rangefinder

Development/Description

Designed for use with tank fire-control systems, the EL-OP laser rangefinder provides high accuracy range measurements using four units: a commander's control; a gunner's control; a laser periscopic sight system; and the control box. The equipment allows either the tank commander or gunner to measure target ranges from 400 up to 4995 m away

Status: In production. In service with unspecified countries.

Manufacturer: EL-OP Electro-Optics Industries Ltd, Advanced Technology Park, Kiryat Weizmann, PO Box 1165, IL-76110 Rehovot, Israel. Telephone: (08) 386221 Telex: 381344 Fax: (08) 386237

SPECIFICATIONS

OPERATING RANGE

400-4995 m (valid limits accepted by computer)

400-9995 m (max attainable range limits)

RANGE ACCURACY +10 m

RESOLUTION 2 targets a minimum of 20 m apart

WEIGHT control unit 5.5 kg

11 kg electronics unit laser periscopic sight assembly 15 kg DIMENSIONS

125 × 130 × 190 mm control unit 330 × 260 × 180 mm electronics unit 325 × 240 × 280 mm laser periscopic sight assembly

EL-OP High Repetition Laser Rangefinder (HRLR) and High Repetition Laser Rangefinder-Eye Safe (HRLR-ES)

Development/Description

The HRLR was developed in direct response to an Israeli Air Force combat requirement for a system that could either be used as a stand-alone unit or integrated into anti-aircraft gun fire-control systems.

The HRLR is a lightweight compact system that is microprocessor controlled and fitted with a serial communications output facility. Integration into an anti-aircraft fire-control system improves the guns' low level accuracy and hit probability at extreme range and reduces the possibility of system detection by virtue of its passive mode of operation relative to the use of a

The Nd-YAG laser has three modes of operation:

- Laser On whereby the system is operative from the moment the HRLR is connected to a power supply
- (b) Laser Standby whereby the simmer power supply is operative and the laser is awaiting a fire command
- (c) Laser Fire whereby the laser transmits pulses in a single shot 10 to 20 pps rate.

SPECIFICATIONS HRLR HRI R-FS WEIGHT approx 13 kg approx 14 kg DIMENSIONS 430 × 260 × 220 mm 430 × 260 × 220 mm LASER TYPE Nd-YAG Nd-YAG WAVELENGTH 1.064 µm 1.54 µm RECEIVER OPERATING RANGE 250 - 19 995 m 250 - 19 995 m

RANGE GATE variable from 300 - 15 000 m 300 - 15 000 m ACCURACY ±5 m

RECEIVER

FIELD-OF-VIEW 2 mrad

BORESIGHT TELESCOPE

magnification x 6

boresight (to laser beam) better than 0.5 mrad better than 0.5 mrad 28 V DC 28 V DC

2 mrad

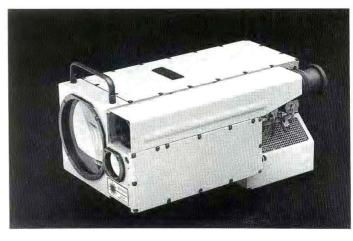
x 6

POWER SUPPLY

Status: Production. In service with Israeli Air Defence Force (anti-aircraft units).

Manufacturer: EL-OP Electro-Optics Industries Limited, Advanced Technology Park, Kiryat Weizmann, PO Box 1165, IL-76110 Rehovot,

Telephone: (08) 386221 Telex: 381344 Fax: (08) 386237



EL-OP High Repetition Laser Rangefinder

ITALY

Alenia MTL-8 Modular Laser Rangefinder

Development/Description

The MTL-8 modular laser rangefinder is available for use in a variety of applications. It has been selected and placed in production for use in the following armoured vehicles of the Italian Army:

- Consortium IVECO FIAT/OTO Melara C1 Ariete MBT
- Consortium IVECO FIAT/OTO Melara B1 (8 x 8) tank destroyer
- Consortium IVECO FIAT/OTO Melara VCC-80 Infantry Fighting (c) Vehicle

- The MTL-8 comprises the following subsystems:
 (i) Laser Transceiver Unit (LTU) with mini Nd-YAG laser transmitter and avalanche photodiode receiver/detector unit sharing the same aperture to minimise integration problems with the host sighting assembly.
 - Laser Electronic Unit (LEU)
- (iii) Appropriate sight and fire-control system interface and cable connectors.

The MTL-8 can also be integrated with many other types of existing day/ night sight assemblies as required.

SPECIFICATIONS

WEIGHT

approx 5.5 kg

DIMENSIONS LTU

 $86 \times 96 \times 150 \text{ mm}$ 70 × 120 × 185 mm

LEU LASER TYPE Nd-YAG WAVELENGTH 1.06 um **OPERATING RANGE** 400-9995 m ACCURACY ± 5 m

REPETITION BATE

up to 1 pps

24 ± 5 V DC with current drawing of 1.5 A POWER SUPPLY at max pulse repetition rate of 1 pps



Alenia MTL-8 laser transceiver and electronic unit

Status: Selected for the Italian Army (B1 tank destroyer, C1 MBT and VCC-80 IFV). As of March 1993 only the B1 Centauro (8 x 8) had entered production and service with the Italian Army.

Manufacturer: Alenia, Aeritalia & Selenia SpA, Defence Systems Group,

Via Tiburtina KM 12.400, I-00131 Rome, Italy. Telephone: 39 (6) 41971 Telex: 43 613690 Alrom I

Alenia GAQ-4 Anti-aircraft System Laser Rangefinder

Development/Description

The GAQ-4 high repetition rate laser rangefinder is intended for use in anti-aircraft fire-control systems and has been adopted as part of the optronic fire-control system used in the Italian Army's SIDAM 25 selfpropelled anti-aircraft gun. Adaption to other fire-control systems can be made by performing minor opto-mechanical and electrical modifications to its modular designed components.

The GAQ-4 comprises the following subsystems:

- a 1.06 µm wavelength laser transmitter module
- (b) a laser receiver module
- a laser electronic unit
- mounting plates and interconnecting cable set. (d)

SPECIFICATIONS

WEIGHT laser transmitter laser receiver electronic unit **DIMENSIONS** laser transmitter laser receiver electronic unit WAVELENGTH OPERATING RANGE ACCURACY REPETITION RATE POWER SUPPLY

approx 10 kg approx 1.5 kg approx 10 kg

 $120\times230\times70~mm$ $330 \times 230 \times 130 \text{ mm}$ 1.06 µm 300-10 235 m 6 m RMS 20 pps

420 × 210 × 100 mm

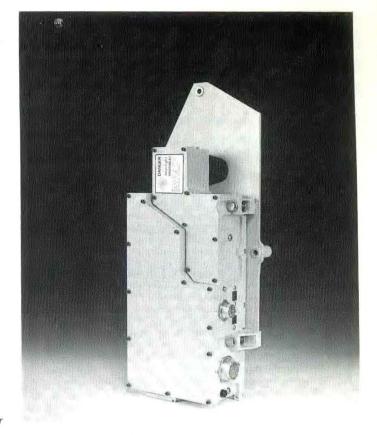
28 V DC and 115 V, 400 Hz with current drawings of 11 A and

0.6 A respectively

Status: Production. In service with the Italian Army (SIDAM 25).

Manufacturer: Alenia, Aeritalia & Selenia SpA, Defence Systems Group,

Via Tiburtina KM 12.400, I-00131 Rome, Italy.
Telephone: 39 (6) 41971 Telex: 43 613690 Alrom I



Alenia GAQ-4 laser transmitter

NETHERLANDS

Oldelft RSI Tank Laser Rangefinder

Development/Description

The Oldelft Rationalisation, Standardisation, Interoperability (RSI) Tank Laser Rangefinder is designed for retrofitting to tanks such as the Centurion, M48 and M60 which use the M35E1 Gunner's Night Vision Periscope. A day aiming system sight and laser rangefinder are combined in one unit to replace the existing daylight elbow in the M35 periscope. For use as part of a fire-control system, a projected graticule channel is provided to display offsets in the eyepiece.

Besides this illuminated aiming graticule, the in-eyepiece display shows measured range, first/last return mode indication, master failure indication and projected graticule (azimuth offset angle).

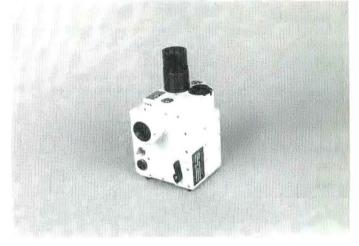
The field-of-view of the rangefinder is 7° with a magnification value of $\times 8$.

Status: In production. In service with several undisclosed countries.

Manufacturer: Oldelft, PO Box 72, NL-2600 MD Delft, Netherlands.

Telephone: (15) 60 19 01 Telex: 38 345

Fax: (15) 14 57 62



Oldelft RSI Tank Laser Rangefinder

Oldelft Type LAT Laser Rangefinder for Tanks

Development/Description

The modular Type LAT universal laser rangefinder has been designed to be mounted either on the gunshield or the turret of an MBT. If required the system can be reconfigured to incorporate the subsystem modules into an existing optical sight or periscope of suitable construction.

The potential target is observed and tracked through the normal aiming sight of the tank and its range measured by the externally mounted LAT unit.

The LAT comprises a laser ranging unit, two control boxes and an interconnecting cable set. The 1.06 µm wavelength Nd-Glass laser operates by sending out a short duration pulse of laser light which is invisible to the human eye. The reflected laser light from the target is processed in the receiver and converted into an electrical signal. An electronic counter, controlled by the signal outputs and inputs and connected to the display panels on the control boxes then gives a distance reading.

The laser system has a multiple target discrimination capability with two available memories. This makes it possible to determine the range of two different targets within the beamwidth of the receiver detector field. The ranges are displayed successively on the displays. Undesired target reflections can be eliminated by the use of the minimum range gate facility.

After a measurement is made the range data are stored in the available



Oldelft Type LAT laser rangefinder for tanks with sight in centre

memories where they remain until the next shot is made. An outlet to transmit this information to the ballistic computer of an integrated firecontrol system is provided.

The unit has a built-in alignment device and calibration telescope with a × 7 magnification and 2° field-of-view.

SPECIFICATIONS

WEIGHT 18 kg
POWER SUPPLY 21-29 V DC

Laser rangefinder

LASER TYPE

WAVELENGTH

LASER RANGE LIMITS

RANGE ACCURACY

DISCRIMINATION

Nd-Glass

1.06 μm

400-6000 m

5 m

< 30 m

Control boxes

RANGE DISPLAY
MULTIPLE TARGET INDICATION

MIN' BANGE

400-9995 m signal light to indicate more than 1

echo received

continuous minimum range setting through control knob

Status: Production as required.

Manufacturer: Oldelft, PO Box 72, NL-2600 MD Delft, Netherlands.

Telephone: (15) 60 19 01 Telex: 38 345 Fax: 14 57 62

NORWAY

SIMRAD LV5 Laser Rangefinder

Development/Description

The LV5 laser rangefinder is designed for external mounting on armoured fighting vehicles to improve their combat effectiveness by providing accurate range information to lay their main armament.

The compact and low-profile laser transceiver unit is mounted on the gun mantlet and accurately boresighted to the gunner's sight.

The control/display unit is mounted inside the turret in a position where it can easily be operated by the gunner. As an option, an additional display unit can be supplied in order to provide both the vehicle commander and gunner with the same range information.

An LED display on the control/display unit presents the ranges of up to two targets with a resolution of 5 m; range discrimination is 30 m. In addition, there are indicators to warn the operator if:

- a) more than two targets have been detected
- b) one or more targets are within the minimum range gate setting
- c) the Nd-YAG 1.064 μm wavelength laser power is low.

An auxiliary data output on the control/display unit provides range information either to an external fire-control system computer or to the additional range display unit of the commander.

Operating range of the LV5 is 150 to 9995 m with a minimum range gate setting infinitely variable from 150 to 4000 m.

SPECIFICATIONS

WEIGHT

transceiver unit 2.2 kg control/display unit 2 kg DIMENSIONS

 $\begin{array}{ll} \text{transceiver unit} & 230 \times 140 \times 95 \text{ mm} \\ \text{control/display unit} & 160 \times 160 \times 90 \text{ mm} \end{array}$

LASER TYPE Nd-YAG



SIMRAD LV5 laser rangefinder for AFV installation showing, from left to right, control/display unit, transceiver and optional display unit

 WAVELENGTH
 1.064 µm

 RECEIVER FIELD-OF-VIEW
 1.3 mrad

 OPERATING RANGE
 150 – 9995 m

 RESOLUTION
 5 m

 DISCRIMINATION
 30 m

RANGE GATE 150 to 4000 m continuously

variable

BORESIGHT SIGHT
MAGNIFICATION × 7

Status: Production.

Manufacturer: SIMRAD Optronics A/S, PO Box 6614, Etterstad, N-0602

Oslo 6, Norway.

SIMRAD LA7 Laser Rangefinder

Development/Description

The LA7 laser rangefinder is designed for use with a wide variety of weapon fire-control systems. It is able to measure ranges up to 10 000 m and its 4 Hz intermittent repetition rate enables engagement of moving targets. Range information is transmitted to the fire-control system via an RS422 data interface and is also displayed in the sighting eyepiece LED display. The sight has a built-in \times 7 magnification capability.

Night vision capability can easily be achieved by mounting the SIMRAD KN200 image intensifier on top of the LA7. A simple dovetail interface enables quick mounting and dismounting. No boresighting is required.



SPECIFICATIONS

DIMENSIONS 222 \times 206 \times 94 mm WEIGHT approx 3.2 kg POWER SUPPLY 24 \pm 5 V DC

Sighting telescope MAGNIFICATION

MAGNIFICATION × 7
FIELD-OF-VIEW 7°

FIELD-OF-VIEW 7°
EYEPIECE SETTING -0.75

EYEPIECE SETTING -0.75 diopters fixed RETICLE ILLUMINATION beta-light

Laser rangefinder

WAVELENGTH 1.064 μm

 PULSE FREQUENCY

 continuous operation
 1.5 Hz

 intermittent operation
 4 Hz

 RANGE DISPLAY LIMITS
 150-9995 m

 RESOLUTION
 5 m

 TARGETS REGISTERED
 3

RANGE GATE LIMITS 150-4000 m
DATA INTERFACE full duplex RS422

Status: Production. In service with undisclosed countries.

Manufacturer: SIMRAD Optronics A/S, PO Box 6614, Etterstad, N-0602

Oslo 6, Norway.

Telephone: 47 2 67 04 90 Fax: 47 2 19 29 91

SIMRAD LA7 laser rangefinder

or last target.

SIMRAD LV350 Series Laser Rangefinders

Development/Description

The LV350 series of laser rangefinders has been designed for easy integration with a wide range of optical vehicle sights. The series consists of the following available models: LV352; LV353; LV354; and LV355, all of which are based on modular design parameters.

In order to simplify the optical arrangements of the sights the transmitter and receiver channels of the LV352/353 and 354 are coaxial. The LV355 has separate transmitter and receiver channels.

The LV350 series can measure target ranges between 150 and 10 000 m with resolution of 5 m. As an option the LV353/354/355 models can be delivered with a range counter for measuring ranges up to 20 000 m. Actual maximum range will depend upon the host sight construction.



SIMRAD LV352 transceiver unit

Status: Production.

Minimum range gate can be set from 150 to 4000 m and a facility for testing the minimum range setting is incorporated. First or last target registration can be selected by the operator.

The LV350 series can provide its output data in serial binary form either to an external microprocessor (LV352 model) or, via opto-couplers, to a fire-control system computer.

A complete LV350 series model laser rangefinder comprises two separate subsystems:

a) a transceiver unit which is designed to be used together with an optical sight that uses a Galilean telescope with a typical magnification of

The unit interfaces mechanically with the sight through dovetail or screw mounts and optically interfaces through a small window in the sight. This arrangement permits a simple installation and removal operation with no re-alignment required after replacement of the laser unit

b) an electronics unit which contains the range counter and voltage converter/filter PCBs. The electronics unit can be specified by the customer to fit his mechanical and electrical equipment requirements. The display can be removed from the range counter PCB thus allowing introduction of the range readout anywhere in the sighting system.

SPECIFICATIONS

WEIGHT	
transceiver unit	approx 2 kg
DIMENSIONS	
transceiver unit	150 × 92 × 90 mm
electronic unit	114 × 90 × 23 mm
WAVELENGTH	1.064 µm
RECEIVER FIELD-OF-VIEW	8 mrad
OPERATING RANGE	150 - 9995 m
RESOLUTION	5 m
RANGE GATE (in first target mode)	150 - 4000 m
NUMBER OF TARGETS REGISTERED	one
RETURN PULSE LOGIC	registration of first

selectable by operator POWER SUPPLY 24 ± 6 V DC (filtered input)

Manufacturer: SIMRAD Optronics A/S, PO Box 6614, Etterstad, N-0602

Oslo 6, Norway.

Telephone: 47 2 67 04 90 Fax: 47 2 19 29 91

SIMRAD LV400 Series Laser Rangefinders

Development/Description

The LV400 series of Nd-YAG laser rangefinders has been designed for integration with a wide range of optical sighting systems.

Based on a modular concept with no forced cooling requirements, these compact systems can either have the main module separately mounted within the sight assembly or built together as one integrated unit. If the control panel or range display is not an integral part of the sight, then a tailor-made display and/or control unit will be supplied.

The optical system transmitter/receiver channels can be coaxial or separate and the receiver field-of-view set according to the customer requirements. The variable range gate and range window requirements are also set according to customer specification.

Up to six targets can be registered by the range counter with up to three target ranges displayed on the optional range display. A bi-directional optocoupled serial datalink interface with RS422 data format is fitted to the range counter for integrating with a fire-control system ballistic computer.

SPECIFICATIONS (typical LV400 system)

WEIGHT separate transceiver unit 2.7 kg control and display unit 2.7 kg **DIMENSIONS**

242 × 112 × 70 mm separate transceiver unit control and display unit 160 × 112 × 170 mm LASER TYPE Nd-YAG **OPERATING RANGE** 200 - 9995 m

(optional 200 - 19 995 m) RESOLUTION 5 m 24 ± 6 V DC POWER SUPPLY

A typical configuration is the SIMRAD LV400 consisting of transceiver unit, transceiver cable, remote range display unit and internal range display (to be mounted inside the sight)

Status: Production.

Manufacturer: SIMRAD Optronics A/S, PO Box 6614, Etterstad, N-0602

Oslo 6. Norway

Telephone: 47 2 67 04 90 Fax: 47 2 19 29 91

SLOVENIA

Iskra TLMD-3 Tank Laser Rangefinder

Development/Description

The TLMD-3 Nd-YAG laser rangefinder system is specially designed for use with the T-54/55/62/72 series of MBTs and is a single unit comprising an optical periscopic sight with a fixed focus day channel and the laser transmission and receiving devices.

Installation is simple, with the existing commander's periscopic sight being removed from its cupola suspension pivot and replaced by the TLMD-3 unit. A power cable is then attached.

In operation it is aimed in azimuth by turning the commander's cupola and in elevation by moving the rangefinder on its suspension pivot. Ranging is performed by depressing the push button control on the right-hand grip. Distances of targets beyond a preset minimum range gate are displayed in the left eyepiece of the periscopic sight.

To aim the gun at the target the commander depresses the left-hand grip push button. If there are two targets within the laser beam both ranges are stored simultaneously. Displays of either the first or second target can then be selected by use of a toggle switch.

The range in digital form can be entered into a fire-control computer or remote display via a data output connector.

SPECIFICATIONS

WEIGHT 10 kg

POWER SUPPLY 20-30 V vehicle supply

Laser rangefinder

RANGE

gated 200-3000 m continuous

 max
 19 995 m

 ACCURACY
 ±5 m

 RESOLUTION
 30 m

Day sight

 MAGNIFICATION
 × 7

 FIELD-OF-VIEW
 6°

 DIOPTER RANGE
 -5 to +5

Status: In production.



Iskra TLMD-3 tank laser rangefinder from commander's side showing controls

Manufacturer: Iskra Elektrooptika Ljubljana D.D., Stegne 7, PO Box 59, 5161210 Ljubljana-Šentvid, Slovenia.

Telephone: (061) 191 215 Telex: 3951851 iskceo

Iskra LD-TŠ Laser Rangefinder for T-55 MBT Gunner's Sight

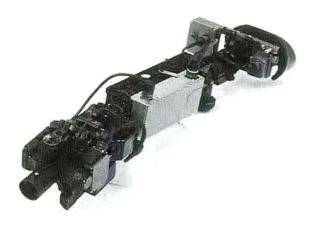
Development

The modular LD-TŠ system is designed to be fitted on the original T-55 MBT's gunner's day sight without the need for any modification work. The transceiver module is fully interchangeable with the front section of the sight assembly. The aiming and firing procedures remain unchanged.

Description

An LD-TŠ laser rangefinder is supplied with the following modules:

a) an advanced second-generation Nd-YAG laser transmitter and receiver that features an emitted peak power of greater than 1 MW and an output energy of greater than 8 MJ. The target range is displayed for the gunner in the eyepiece with indicators given for laser low power and second echo.



Iskra LD-TŠ laser rangefinder designed for installation in T-54/T-55/T-62 MBTs with gunner's eyepiece to the right

Laser firing is achieved by a foot pedal unit or by a switch on the gunner's control unit. The rate of fire is one pulse every two seconds which can be maintained on a continuous basis if needed.

When installed on the T-55 the 16 mm gunner's sight slit enables the LD-TŠ to accurately target range out to 4990 m. If the turret slit had not reduced the receiver aperture capability then the maximum accurate targeting range would have been 6995 m

b) logic module

c) gunner's control module on which he can select first or second pulse.
 He can also set the minimum range gate from 200 m upwards on a continuous setting and fire the laser

d) commander's display on which the target range is given by an LED unit

e) gunner's foot pedal unit for firing the laser

f) installation kit and interconnecting cable set.

SPECIFICATIONS

Sight

MAGNIFICATION ×7

Laser rangefinder

LASER TYPE Nd-YAG
LASER RANGE LIMITS 300-10 000 m
LASER BEAM WIDTH (90%

energy) 1.2 mrad
GATING LIMITS 300-3000 m

MAX NUMBER OF TARGETS MEASURED

MEASURED two
POWER SUPPLY 20-30 V DC

Status: Production.

Manufacturer: Iskra Elektrooptika Ljubljana D.D., Stegne 7, PO Box 59, 5161210 Ljubljana-Šentvid, Slovenia.

Telephone: (061) 191 215 Telex: 3951851 iskceo

SOUTH AFRICA

Eloptro LT-20 Laser Rangefinder

Development/Description

The LT-20 laser rangefinder is a high accuracy, high pulse repetition frequency device for use in tracking aircraft on test ranges and for antiaircraft systems.

It is controlled by computer link with signals for first/last target, divergence control, search and track mode control, safety range control and transmitter control



SPECIFICATIONS

DIMENSIONS WEIGHT (inc batteries) POWER SUPPLY

COMMUNICATIONS/CONTROLS

255 × 180 × 430 mm

17 kg

28 ± 4 V DC or 220 V, 50 Hz AC SDLC Format, 50 Hz maximum message rate, 244 kBaud max bit rate

Laser transmitter

LASER TYPE Nd-YAG LASER WAVELENGTH 1.064 um LASER PULSE ENERGY 80 ± 20 mJ PULSE WIDTH 10 - 20 nsec

BEAM DIVERGENCE switchable between 1 ± 0.2 mrad or

4 + 1 mrad

Laser receiver

FIFLD-OF-VIEW LENS DIAMETER SENSITIVITY

4 mrad 120 mm

65 536 m

128 m wide

200 m

50 nwatt at 1.064 μm

Laser rangefinder

MAX RANGE MIN RANGE

DYNAMIC RANGE GATE selectable in/out

TARGET DISCRIMINATION RANGE RESOLUTION ACCURACY

MIN RANGE

EYE SAFETY CONTROL

selectable in/out

RANGE LOGIC

±1 m

200 m

automatic, divergence control and

filter attentuation control

30 m between targets

first/last target

Status: Production as required. In service with the South African Defence Forces.

Manufacturer: Eloptro (Pty) Ltd.

Enquiries to: Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635

Eloptro LR 20 Laser Rangefinder

Development/Description

The LR 20 is a compact, lightweight laser rangefinder designed for use in tracking aircraft on test ranges and for anti-aircraft systems. It provides accurate range data at a rate of up to 20 measurements per second.

It has a built-in servo controller 20 dB attenuation filter and beam shutter, an external 30 dB eye safety filter, a hard-wired safety shut-down and full built-in test of all the modules including the laser transmitter receiver, filter servo and range logic.

SPECIFICATIONS

DIMENSIONS including cooling unit 390 × 200 × 220 mm approx 390 × 200 × 155 mm without cooling unit WEIGHT 10.4 kg POWER SUPPLY 18-32 V DC

Laser transmitter

LASER WAVELENGTH $1.064~\mu m \pm 1~\mu m$ LASER PULSE ENERGY $80 \pm 20 \text{ mJ}$ PULSE WIDTH 15-25 nsec

Laser receiver

FIELD-OF-VIEW 1-4 mrad (preset) LENS DIAMETER 120 mm SENSITIVITY >55 dB extinction

Laser rangefinder

WIDTH

MAXIMUM RANGE 20 400 m (40 800 m long-range

mode)

ACCURACY ±5 m (±10 m long-range mode) RESOLUTION

50 m

MIN RANGE 50 m (short-range mode)

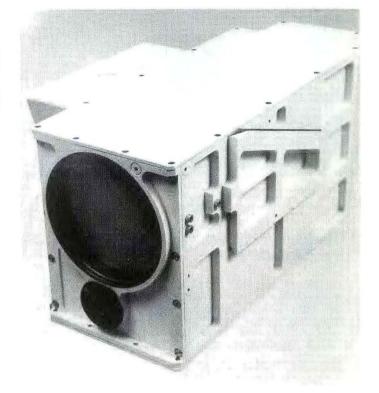
330 m (medium-range mode) 660 m (long-range mode) 50-20 400 m (660-40 800 m

RANGE GATE CENTRE POSITION

long-range mode) 50-1200 m (50-2400 m long-range

mode) first/last target modes

RANGE LOGIC RANGING RATE 0-20 Hz



Eloptro LR 20 laser rangefinder

Status: Production as required. In service with undisclosed countries.

Manufacturer: Eloptro (Pty) Ltd. Enquiries to Armscor, Private Bag X337,

Pretoria 0001, South Africa.

Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635

UNITED KINGDOM

Avimo TL10-T Articulated Telescope Laser Rangefinder

Development/Description

The TL10-T is designed to be integrated into the T-series MBT gunner's articulated telescopic sight by replacing the forward objective lens assembly to give an Nd-YAG laser rangefinding capability.

The laser assembly incorporates an aiming mark injection facility for interfacing with a computerised fire-control system. Range and aiming mark data are displayed in the secondary eyepiece assembly also

The basic operating controls are located on a remote panel mounted on the body of the telescope adjacent to the eyepiece.

Status: Production.

Manufacturer: Avimo Ltd, (a subsidiary of United Scientific Holdings plc) Lisieux Way, Taunton, Somerset, TA1 2JZ, UK.

Telephone: (0823) 331071 Telex: 46126 Fax: (0823) 274413



Avimo TL10-T articulated telescope laser designed for installation in T-series **MBTs**

Barr & Stroud LF19 Laser Rangefinder

Development/Description

The LF19 laser rangefinder has been developed using technology from the Nd-YAG laser module which is used in the Barr & Stroud Tank Laser Sight of the Challenger 1 MBT. The LF19 has also been incorporated into the Challenger 2 MBT GPS assembly.

The LF19 can also be used for external mounting on the armoured fighting vehicle, and, when boresighted to existing equipment, can be adapted to suit a variety of applications including improving armament effectiveness by providing accurate range information for aiming purposes.

The main subsystems are:

1) optical head unit which contains the laser transmitter/receiver circuits and can be fitted with a telescopic sight attachment mechanism for boresight alignment purposes



Barr and Stroud LF19 laser rangefinder

- 2) electronics unit which contains all the rangefinder's processing circuits and can be directly interfaced to a fire-control system computer for range display and ballistic calculations
- 3) control and display unit for those applications where no fire-control computer is used. This contains the laser switches, supply filters and a three-digit LED display with the option of either a variable minimum range selection with single displays or a user selectable multiple returns with three displays operating mode
 - 4) interconnecting electrical/optical cable set.
- In an advanced state of development is a new electronics unit which contains both laser and video processing electronics. This will accept standard charge-coupled infra-red signals from either a TV/low-light TV camera or thermal imaging sensor head, and interfaces with the fire-control computer to allow the injection of computer generated text and symbols on to the TV picture.

The unit will therefore, with the rangefinder optical head, form a system that displays simultaneously the target range, aiming marks and ballistic information for the operator.

SPECIFICATIONS

DIMENSIONS optical head 240 × 110 × 70 mm electronics unit 270 × 140 × 100 mm LASER TYPE Nd-YAG WAVELENGTH 1.064 µm 300-9990 m **OPERATING RANGE** ACCURACY ±10 m RECEIVER FIELD-OF-VIEW 0.75 mrad

Status: Ready for production. Incorporated into Challenger 2 MBT GPS assembly

Manufacturer: Barr & Stroud Limited, 1, Linthouse Road, Glasgow G51 4BZ, Scotland, UK,

Telephone: (041) 440 4000 Telex: 778114 GLW G Fax: (041) 440 4001

GEC-Ferranti Type 629 Lightweight Modular Laser Rangefinder

Development/Description

The Type 629 is a multi-role Nd-YAG laser rangefinder system with variants being used for a number of applications in the armies of several countries.

In March 1987 an order for 38 Type 629G lasers was placed for use with the M113A2 mounted ADATS air defence system. A further variant of the Type 629 is also supplied for use in the British Aerospace Laserfire air defence system.

The common transmit/receive optical path arrangement also allows the laser to be integrated into the gunner's gyrostabilised sight assembly of an armoured vehicle

22-30 V DC

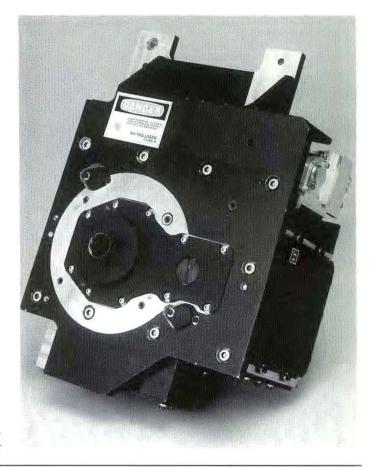
SPECIFICATIONS

POWER SUPPLY

WEIGHT 6 kg 200 × 180 × 130 mm **DIMENSIONS** Nd-YAG LASER TYPE LASER RANGE LIMITS 300-10 000 m ACCURACY 2.5 m

Status: Production. In service with Canada and a number of other undisclosed countries.

Manufacturer: GEC-Ferranti Defence Systems Ltd, Display Systems Division, 1 South Gyle Crescent, Edinburgh, EH12 9HQ, UK. Telephone: (031) 316 4545 Telex: 727101 Fax: (031) 314 8237



GEC-Ferranti Defence Systems Ltd Type 629 lightweight modular laser rangefinder

GEC-Ferranti Type 520 Laser Rangefinder

Development/Description

The Type 520 third-generation Nd-YAG 1.064 µm wavelength laser rangefinder is designed for integration into armoured fighting vehicle sights such as the NANOQUEST L20 series (L20 for the Scorpion reconnaissance vehicle and L22 for the Chieftain MBT), ML Aviation T-sight (for the T-series tanks), M48A5 periscope retrofit kit and the GEC Sensors day/night Argus system for vehicles such as the ENGESA EE-9 Cascavel armoured car.

The Type 520 subsystems for the latter comprise the following:

1) commander's remote display



GEC-Ferranti Defence Systems Ltd Type 520 laser rangefinder

2) laser transceiver unit with receiver, optical and power supply modules. The transmitter and receiver channels are combined to form a coaxial system. A beam expander with × 10 magnification optics can also be used with this unit

3) gunner's sight display unit

4) electronics unit providing the control logic for the power supply and converting the returned laser light pulses to range data for the visual display(s) and, if required, digital output for a fire-control system ballistic computer

5) interconnecting cable set.

The other sight systems have similar sets of components but packaged according to their individual needs.

SPECIFICATIONS

DIMENSIONS (transceiver unit) 148 × 90 × 86 mm WEIGHT (transceiver unit) 2 kg LASER TYPE Nd-YAG WAVELENGTH 1.064 µm OPERATING RANGE 300-9995 m ACCURACY ±5 m RESOLUTION 5 m DISCRIMINATION 30 m DIMENSIONS

configuration to suit application (electronics unit) WEIGHT

(electronics unit) 0.75 kg

Status: Production. In service with Oman (as part of the NANOQUEST L22 sight assembly for the Qayis Al Ardh (Chieftain) MBT and the NANOQUEST L20 sight assembly for the Scorpion reconnaissance vehicle) and several other unspecified countries.

Manufacturer: GEC-Ferranti Defence Systems Ltd, Display Systems Division, 1 South Gyle Crescent, Edinburgh, EH12 9HQ, UK. Telephone: (031) 314 4545 Telex: 727101 Fax: (031) 314 8237

ML Aviation 'T' Tank Gunner's Telescopic Laser Rangefinder Sight

Development/Description

The 'T' tank gunner's telescopic sight (or 'T' Sight) was specifically developed as a private venture from 1984 and is designed as a complete replacement for the existing 'T' series gunner's day sight.

The telescope incorporates a GEC-Ferranti Nd-YAG Laser Range Finder (LRF) with digital range readout which gives both the gunner and commander an instant and accurate range to target figure. If required, the LRF module can be quickly replaced, without the need to re-align, whilst the system remains in station.

The telescope can also be coupled to either the LLLTV or thermal imaging remote night vision system, resulting in the gunner having a 24 hour sighting capability through a single eyepiece.

The 'T' Sight has three build standards:

- (a) CD 0011 with CRT and LRF for use with fire-control system computers (b) CD 0013 with LRF only
- (c) CD 0017 for use with a fire-control system computer and remote sensors. The equipment is capable of being upgraded from its basic form to reflect the higher build standards.

In comparison to the original gunner's sight, the 'T' Sight telescope is much lighter in weight and is easily installed without the need to modify the armour.

15 kg (including LRF)

Nd-YAG

30 m

5 m

1.064 µm

GEC Ferranti Type 520T Mk 2

300-9995 m (display limit)

SPECIFICATIONS

WEIGHT FIELD-OF-VIEW

 \times 8 magnification 8.5° narrow \times 4 magnification 17° wide

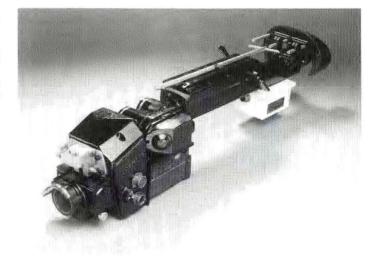
POWER SUPPLY 24 ± 6 V DC vehicle system

Laser rangefinder

MODEL LASER TYPE WAVELENGTH OPERATING RANGE ACCURACY DISCRIMINATION

DISCRIMINATION RESOLUTION

Status: Ready for production.



ML Aviation 'T' sight complete with laser rangefinder

Manufacturer: ML Aviation Ltd, Arkay House, Weyhill Road, Andover,

Hants, SP10 3NR, England.

Telephone: (0264) 333322 Telex: 47692 WALIND G Fax: (0264) 332186

UNITED STATES OF AMERICA

Hughes M1 MBT Laser Rangefinder

Development/Description

The Hughes M1 Abrams Nd-YAG laser rangefinder programme started in 1978, with first deliveries being made in late 1979. The rangefinder consists of a transmitter, receiver, power supply, timing and logic circuit which is integrated as a whole into the tank's fire-control system.

For the M1A2 MBT, Hughes has upgraded the unit with a one laser pulse per second capability, which will significantly increase the accuracy of the fire-control system when used against rapidly moving targets.

In operation the tank crew member aims at a target and triggers the laser. The beam travels to the target and is reflected back towards a receiving telescope. The elapsed time of beam travel to and from the target provides the accurate range information for the fire-control computer. This is then processed with other parameters to give the correct azimuth and elevation figures to engage the target with the main gun.

The system is capable of allowing the fire-control system to differentiate between close-up and far-off targets by allowing the gunner to select the first laser reflection signal (close target) or the last (far target).

Status: M1 Nd-YAG laser rangefinder – in production (over 9500 delivered by January 1993). In service with the United States Army.

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems, PO Box 902, El Segundo, California 90245, United States of America. Telephone: 310 616 1022 Telex: 3486 290

Hughes M1 MBT laser rangefinder



Hughes High Repetition Rate Eyesafe Laser Rangefinder

Development/Description

Hughes has used current technology to cost effectively make electro-optical anit-aircraft fire-control systems safe to operate even in heavy air traffic areas by the introduction of the 15 Hz Raman shifted laser rangefinder operating at 1.54 μm .

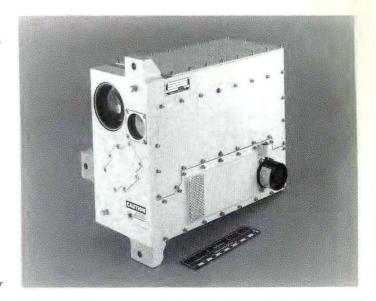
It enables accurate gun fire-control against high speed targets. The output energy is 35 mJ, which provides a class III A eyesafe operation. The system has been demonstrated to the US Army and US Navy and in a number of foreign countries.

Operating life of the Raman cell, which uses a unique Hughes design to allow continuous operation in excess of 20 Hz, has proven to be remarkably reliable. The small one piece unit operates from a 28 V DC power supply.

Status: Development complete.

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems, PO Box 902, El Segundo, California 90245, USA.

Telephone: 310 616 1022 Telex: 3486 290



Hughes high repetition rate eyesafe laser rangefinder

Hughes Low Repetition Rate Eyesafe Laser Rangefinder

Development/Description

Hughes has used current technology to cost effectively make solid state laser rangefinders for military vehicles eyesafe at 1.54 µm.

The use of a small intracavity Raman cell, an avalanche photodiode, provides 10 000 m ranging capability at a class 1.6 mJ output. The low repetition rate eyesafe rangefinder produced operates up to 1 Hz.

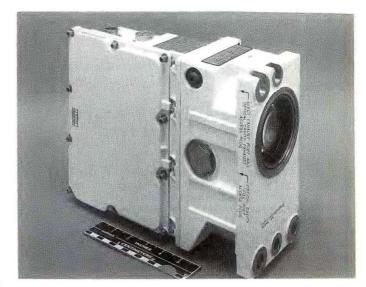
The system has been demonstrated on the US Army M1 Abrams and Bradley Fighting Vehicle. It also has applications for the M60 tank and other armoured vehicles upgrades. The eyesafe rangefinder also incorporates components from the Hughes M1 MBT laser rangefinder (qv previous entry).

Status: Development complete.

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems, PO Box 902, El Segundo, California 90245, USA.

Telephone: 310 616 1022 Telex: 3486 290

Hughes low repetition rate eyesafe laser rangefinder



Litton TK-640 Laser Rangefinder

Development/Description

The TK-640 Nd-YAG 1.064 µm wavelength laser rangefinder is designed for adaption as an onboard fire-control system for several platforms, including

The range data are provided as a parallel digital output to the rest of the system

SPECIFICATIONS

DIMENSIONS (transceiver) WEIGHT (transceiver) LASER TYPE WAVELENGTH MAX OPERATING RANGE RESOLUTION

Status: Ready for production.

 $190\times56\times102~mm$ 2.3 kg Nd-YAG 1.064 µm 9995 m 5 m

Manufacturer: Litton Laser Systems, PO Box 7300, Orlando, Florida, USA.

Optic Electronic E*GLE Laser Rangefinder Kit

Development/Description

The E*GLE Erbium-glass eye-safe laser rangefinder kit has been developed as a direct retrofit for incorporation into the Bradley Fighting Vehicle gunner's Integrated Sight Unit (ISU) in order to give accurate range data up to 10 000 m for both the gunner and vehicle commander.

The kit includes super-elevation control which is automatically updated with each range to target. The system warns with a flashing sequence that indicates 'out-of-range' for both the 25 mm cannon and TOW ATGW systems. An optional commander's remote unit for range display and fire capability is available

The system eliminates the need for range estimation and manual elevation settings. Installation can easily be accomplished at depot level in a few hours after some initial training.

A summary of the various messages on the rangefinder operational display is given in the table.

RANGEFINDER OPERATIONAL DISPLAY

LRF Mode On-initialise Fire LRF Multi-target No return Gun target out of range (>3000 m) TOW target out of range (>3750 m) Off (manual)

LED Reticle Display Display '00' Display Range Blink range Display '99 Display range blink ammo indicator Display range blink TOW indicator Range display updates to manual setting

Super-elevation Update to 1200 m Automatic update Automatic update Update to 1200 m Updates to 3000 m

Not applicable

Super-elevation updates to manual settina

Note: The US Army Environmental Hygiene Agency has type classified Erbium-glass laser rangefinders as eye-safe for all military operational uses.

SPECIFICATIONS

LASER TYPE
WAVELENGTH
RECEIVER FIELD-OF-VIEW
OPERATING RANGE
ACCURACY
RESOLUTION

DISCRIMINATION LOGIC PRESENTATION POWER SUPPLY Erbium-glass 1.54 μm 1.5 mrad 100-9995 m ±5 m

100 m in ISU display 5 m in optional remote display

first/last target selection

2 digit LED

24 ± 6 V DC vehicle system

Status: Production as required.

Manufacturer: Optic Electronic Corporation 11545 Pagemill Road, PO Box 740668, Texas 73574-0668, USA.

Telephone: (214) 349 0190 Telex: 910 861 9312 Fax: (214) 343 7529

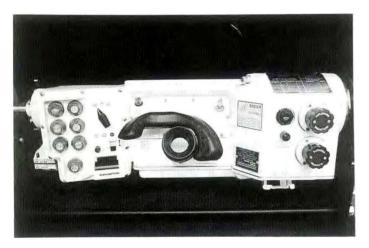
E*GLE laser rangefinder kit for the Bradley gunner's ISU

Optic Electronic AN/VVG-2 Commander's Integrated Laser Rangefinder

Development/Description

The AN/VVG-2 commander's laser rangefinder sight system was developed for the late model M60A3 MBT although it can also be retrofitted into earlier M60 models to give improved fire-control performance.

The system is located at the commander's station and has an optical system equipped with a low magnification viewing mode for acquiring targets and a high magnification viewing mode for lasing and gun laying. In addition, the optical system serves as the commander's primary sight for directing the fire of the main 105 mm armament. It also provides a means of introducing azimuth corrections into the pointing of the laser rangefinder to compensate for a target lead and as a way to check the boresight of the laser rangefinder with respect to the main gun. A Built-in Test capability is provided to check overall system operation.



OEC AN/VVG-2 commander's integrated laser rangefinder

Either the commander or the gunner can fire the laser but the return range data is only displayed at the commander's station. The system has the capability of storing data on as many as three targets that intercept the laser beam. The range to these stored targets can be displayed upon command. The equipment is designed so that the range return information can either be automatically made available to the fire-control system ballistic computer or be fed manually into the system.

Optic Electronic suggests that the AN/VVG-2 be included as part of a complete sight upgrade package which uses a compatible gunner's day/night periscopic sight (eg the Optic Electronic MP86 – qv entry next section) and driver's night vision viewer (eg the Optic Electronic NV43M passive night vision viewer – qv entry previous section). The older design M35E1 gunner's periscope can also be installed.

SPECIFICATIONS

WEIGHT	40.9 kg
DIMENSIONS	406 × 1016 × 279 mm
POWER SUPPLY	24 \pm 6 V DC vehicle system

Sight

FIELD-OF-VIEW	
× 6 magnification	10°
× 12 magnification	5°
DIOPTER RANGE	-2.8 to +2.8

Laser rangefinder

LASER TYPE	Ruby
WAVELENGTH	0.694 μm
LASER BEAM POINTING	
azimuth	10°
depression/elevation	-10° to +20°
OPERATING RANGE	200-5000 m
ACCURACY	±10 m
DISCRIMINATION	2 targets at 20 m separation

Status: Production as required. In service with undisclosed countries.

Manufacturer: Optic Electronic Corporation, 11545 Pagemill Road, PO Box 740668, Dallas, Texas 73574-0668, USA.

Telephone: (214) 349 0190 Telex: (910) 861 9312 Fax: (214) 343 7529

Texas Instruments TTS Laser Rangefinder

Development/Description

For fitting on their AN/VSG-2 Tank Thermal Sight used in the M60A3 MBT upgrade programme, Texas Instruments has produced an Nd-YAG laser rangefinder unit of conventional pattern.

The device has a first and last target switch with the range being shown in metres on an LED display panel. Target separation capability is 20 m.

SPECIFICATIONS

Status: Production as required. In service with the US Army.

Manufacturer: Texas Instruments Inc, Defense Systems & Electronics Group, PO Box 660246, Dallas, Texas 75266, USA.
Telephone: (214) 480 6241 Telex: 470900/8674 702

Texas Instruments Avenger Laser Rangefinder

Development/Description

Texas Instruments has produced a Carbon Dioxide (CO₂) laser rangefinder that provides eyesafe range and range rate data for the Boeing Avenger Line-of-Sight Rear (LOS-R) air defence weapon system. It is the first production CO₂ laser rangefinder to enter the US Army inventory.

The device is a stand alone unit that can be used on multiple platforms to receive the range information provided the renge in the renge

provide the range information previously mentioned above.

SPECIFICATIONS

CO₂ 10.59 μm LASER TYPE WAVELENGTH **OPERATING RANGE** 500-9990 m ACCURACY

Status: Production (over 500 units delivered by the end of 1993 - deliveries under a multi-year production contract began in 1992). In service with the US Army (Avenger LOS-R).

Manufacturer: Texas Instruments Inc, Defense Systems & Electronics Group, PO Box 660246, Dallas, Texas 75266, USA. Telephone: (214) 480 6241 Telex: 470900/8674 702



Texas Instruments Avenger Laser Rangefinder

Commanders' and Gunners' Day and Night Observation and Sighting Systems

BELGIUM

SABCA Thermal Imaging Sight (TIS) System for Leopard 1 MBT

Development/Description

As part of the Belgian Army's Leopard 1 MBT fire control system upgrade package, SABCA developed and manufactured a thermal imaging poor visibility/night sight system which has been integrated into the gunner's main day/night laser rangefinder sight assembly by another contractor.



Close-up of the commander's and gunner's position of a Leopard 1 MBT of the Belgian Army fitted with the Improved Laser Tank Fire Control System with 105 mm gun on left

The system is based on GEC Avionics TICM II module (qv) which uses the passive detection of infra-red radiation emitted naturally by any object whose temperature is above 0° K to trigger detector elements. The electronic signals so generated are then translated into a realistic image which is displayed on a black and white TV-type screen, the various tones of which reflect the temperature differences between the objects being viewed.

The system is capable of detecting targets more than 4000 m away and identifying targets up to the size of an MBT or helicopter at ranges of over 2000 m, even if they are camouflaged, because it can sense temperature differences of only a few hundredths of a degree.

The modified TICM II module used has a free aperture diameter of 150 mm for an active aperture diaphragm diameter of 120 mm. The day and night images are observed in the gunner's sight through the same eyepieces while the commander has his own TV screen upon which the images seen by the gunner are displayed.

The system includes a control unit, remote display unit and an electronics unit apart from the TICM II module.

SPECIFICATIONS

 MAGNIFICATION

 wide field
 × 8

 narrow field
 × 17.4

 FIELD-OF-VIEW

 wide field
 13° × 7°

 narrow field
 2° 3' × 3° 5'

Status: Production. In service with the Belgian Army (on Leopard 1 MBT upgrades).

Manufacturer: Société Anonyme Belge des Constructions Aéronautiques (SABCA), Electronics Department, 1470 Chaussée de Haecht, B-1130 Brussels, Belgium.

Telephone: (02) 216 80 10 Telex: 21237 Fax: (02) 216 15 70

CHINA, PEOPLE'S REPUBLIC

NORINCO Type 79-II Tank Gunner's Sight

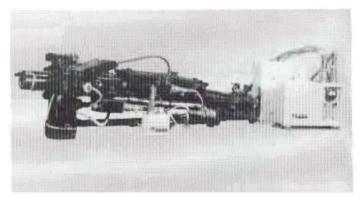
Development/Description

The Type 79-II (or WC 532) tank gunner's sight incorporates a secondgeneration image intensifier tube and is designed for fitting to the T-series of MBTs. The external fitting comprises a casing for a periscope attachment. Internally there are the control and power regulation boxes.

SPECIFICATIONS

WEIGHT 22 kg (total) LENGTH 490 mm WIDTH 248 mm HEIGHT 406 mm MAGNIFICATION FIELD-OF-VIEW DIOPTER RANGE -5 to +5 **FOCUS** 100 m to infinity POWER SUPPLY 26 ±4 V vehicle supply

Status: In production. In service with the Chinese Armed Forces.



NORINCO Type 79-II Tank Gunner's Sight

Manufacturer: China North Industries Corporation, 7A Yuetan Nanjie, Beijing, People's Republic of China.

Telephone: 86 3461/3471/7570 Telex: 22339 CNIC CN

FRANCE

APX M504 Gunner's Optical Sight and Rangefinder

Development/Description

The APX M504 gunner's optical sight and rangefinder is part of the COTAC fire control system designed for the AMX-10RC reconnaissance vehicle. It comprises the following subsystems:

(a) a × 10 magnification SOPELEM optical sight with a 120 mil field-of-view

(b) a CILAS Nd-Glass 1.064 µm laser rangefinder module with a maximum range of 10 000 m. Its accuracy is ±5 m regardless of the distance of the target. If two echoes are received their presence is indicated by a pilot light and the operator then chooses one for display

(c) a Giat Industries line-of-sight deflector which is used to introduce automatic fire corrections into the optical sight.

In operation all the gunner has to do is acquire the target in his optical sight and trigger the laser rangefinder. He then inserts the corrections, which have been calculated by the ballistic computer using the range data, target angular speed in two axes, vehicle cant angle and meteorological data, and fires the main armament.

SPECIFICATIONS

DIMENSIONS

laser rangefinder 250 × 110 × 150 mm

WEIGHT

laser rangefinder 3.5 kg LASER TYPE Nd-Glass WAVELENGTH 1.064 µm RECEIVER FIELD-OF-VIEW 0.5 mrad

OPTICAL SIGHT

magnification field-of-view 120 mil

Status: Production. In service with France, Morocco and Qatar.

Manufacturers: (Laser rangefinder)

CILAS, route de Nozay, F-91460 Marcoussis, France.

Telephone: (1) 64 49 13 25 Telex:691862

(Optical sight)

Société d'Optique, Précision, Electronique et Mécanique (SOPELEM),

19 boulevard Ney, F-75018 Paris, France.
Telephone: (1) 42 02 89 80 Telex: 680428F Fax: (1) 42 02 00 60

(Line-of-sight deflector)

Giat Industries, 13 route de la Miniére, F-78034 Versailles Cedex, France.

Telephone: (1) 30 97 37 37 Fax: (1) 30 97 39 00

SAGEM M389 Commander's Panoramic Sight

Development/Description

The M389 panoramic sight has been developed for use at the commander's station of armoured fighting vehicle turrets such as the 105 TGG of the AMX-10 RC reconnaissance vehicle.

The sight can be used for all-round observation, acquiring a target designated by the gunner, designating a target for the gunner, firing the auxiliary armament and, in the case of an emergency, firing the 105 mm main armament whose axis appears within the field-of-view of the sight. For the machine gun a × 2 graticule is automatically projected into the commander's field-of-view, while for the main gun a x 8 graticule is automatically projected.

The sight comprises:

- (1) a rotating upper assembly which comprises the optical head prism, optical system slaving servo-mechanism and several electrical circuits
- (2) rotating seal which connects the upper assembly to the fixed lower body casing
- (3) fixed lower body which contains the electronic control equipment and eyepiece unit. The electronics provide the following functions:
 - (a) turret counter-rotation slaving so as to isolate the sight from the turret movements
 - (b) slaving of the sight/gun axes in azimuth and the head prism/oscillating unit axes in elevation
 - (c) slaving of the gun/sight axes in azimuth and the oscillating unit/head prism axes in elevation.

SPECIFICATIONS

DIMENSIONS

diameter 190 mm height 632 mm WEIGHT 31.5 kg

MAGNIFICATION 560 mil field-of-view

× 2 140 mil field-of-view $\times 8$

ELEVATION RANGE -12° to +24°

POWER SUPPLY 27 V DC vehicle system



SAGEM M389 Commander's Panoramic Sight as used on the 105 TGG turret of the AMX-10RC reconnaissance vehicle

Status: Production. In service with the French (AMX-10RC), Moroccan (AMX-10RC) and Qatar armies.

Manufacturer: Société d'Applications Générales d'Electricité et de Mécanique (SAGEM), Département Viseurs, 6 avenue d'Iéna, F-75783 Paris Cedex 16. France.

Telephone: (1) 40 70 63 63 Telex: 205255 F Fax (1) 40 70 67 13

SAGEM VIGY 40 Commander's Modular Stabilised Panoramic Sight

Development/Description

The VIGY 40 modular stabilised panoramic sight family has been designed for use in a number of applications on armoured fighting vehicles:

- (a) day/night CPS for MBT (day channel and night channel)
- (b) day/night CPS for ICV (day channel, night channel and laser rangefinding)
- (c) electro-optical tracking systems for anti-aircraft vehicles (Charged Couple Device (CCD) channel, night channel and high rate laser rangefinder)
- (d) night CPS for MBT or reconnaissance vehicle (night channel)

*Note: This configuration can be easily fitted to the roof of most existing turrets without any major internal modifications.

The VIGY 40 system comprises the following subassemblies:

- (a) a rotating head with a two-axis stabilised mirror (b) a dual magnification thermal imager
- (c) a dual magnification day channel system
- (d) a laser rangefinder
- (e) an electronics unit with a tracker and system databus interface (to allow fire control computations)
- (f) a CCD TV camera
- (g) a TV monitor
- (h) a vertical interface.

The subassemblies used in the VIGY 40 system are chosen by the customer according to his particular application requirements.



SPECIFICATIONS Thermal imager

DETECTION RANGE

6-8000 m ground targets airborne targets >10 000 m

Laser rangefinder

WAVELENGTH 1.06 μm or eyesafe 1.54 μm LASER RATE 1 to 12.5 Hz

Day channel

DEPRESSION/ELEVATION -20 to +60° or -10 to +75° AZIMIJTH 360

MAGNIFICATIONS \times 8 and \times 2 LINE-OF-SIGHT STABILISATION < 0.1 mrad

Status: Pre-series production. In operation on a French developed AFV

Manufacturer: Société d'Applications Générales d'Electricité et de Mécanique (SAGEM), Département Viseurs, 6 avenue d'Iéna, F-75783 Paris Cedex 16, France.

Telephone: (1) 40 70 63 63 Telex: 205255 F Fax: (1) 40 70 67 13

SAGEM VIGY 40 panoramic sight with two-axis stabilised mirror, dual magnification day channel, night channel and laser rangefinder

SAGEM Stabilised Aiming, Vertical Sensing and Navigation (SAVAN) Gunner's Multi-channel Stabilised Sight

Development/Description

The modular SAVAN family of sights has been developed specifically for use by MBT gunners in the anti-tank role. It has been selected by the French Army for use on the Leclerc MBT (Viseur Tireur Intégré: VTI) and by Vickers Defence Systems (Stabilised Aiming Mirror System: SAMS) for use on the Challenger 2 MBT for the British Army

The current family of SAGEM SAVAN sights comprises two main members

- (a) SAVAN 20 a day/night GPS with a very large stabilised mirror
- (b) SAVAN 10 a day GPS with flattest stabilisation mirror assembly

Both systems can be integrated with:

- (a) customer specified optronic sensors
- (b) customer specified databus interfaces (for example 1553, Digibus, RS422 and so on)
- (c) customer specified inertial functions (for example two-axis stabilisation of the line-of-sight, vertical sensing, North seeking device, land navigation system and so on).

Description

Leclerc Application (French Army)

The HL 60 GPS designed by SAGEM for the Leclerc MBT comprises three main subsystems:

- (1) a stabilised aiming mirror assembly that allows:
 - (a) 2-axis line-of-sight stabilisation (50 μrad)
 - (b) dynamic vertical reference
 - North seeking (<3 mil)
 - (d) land navigation (<0.3 per cent)
 - (e) gun and turret stabilisation
- (2) a target acquisition assembly which consists of various customer selector sensors
 - (a) dual magnification day channel
 - (b) three magnification 8-12 μm waveband thermal imager
 - Charged Couple Device (CCD) TV camera (C)
 - Nd-YAG laser rangefinder (d)
 - TV monitor (e)
 - symbol generator
 - automatic muzzle reference system
- (3) a modular digital electronics assembly that includes a 1 Mbyte/s Digibus databus interface



SAGEM SAVAN gunner's multi-channel sight equipped with two-axis stabilisation, dual magnification day channel (top left), night channel (right) and CCD TV channel

Challenger 2 Application (British Army)

The SAM GPS selected for the Challenger 2 MBT comprises two main subsystems:

- (1) a stabilised aiming mirror assembly that allows:
 - (a) 2-axis line-of-sight stabilisation (50 μrad)
 - (b) dynamic vertical reference
- (2) a modular digital electronics assembly that includes a 1 Mbyte/s 1553 databus interface

Status: Production. In service with French Army (Leclerc MBT) and British Army (Challenger 2).

Manufacturer: Société d'Applications Générales d'Electricité et de Mécanique (SAGEM), Département Viseurs, 6 avenue d'Iéna, F-75783 Paris Cedex 16, France.

Telephone: (1) 40 70 63 63 Telex: 205255 F Fax: (1) 40 70 67 13

Stabilised Aiming Mirror System of Barr and Stroud day and night sight for use on the Vickers Defence Systems Challenger 2 MBT

SFIM VS 580 Family of Gyrostabilised Sights

Development/Description

The VS 580 family of gyrostabilised sights is intended for the detection, recognition, identification and acquisition of targets from a moving combat vehicle by means of accurate line-of-sight stabilisation.

At present VS 580 sights are compatible with a large number of existing fire control systems. The VS580 is used at the Commander's station of the AMX-40 MBT, Vickers Mk 7B MBT, Challenger 2, Type 88 MBT and the OF-40 MBT. The VS580 is also offered for modernising AMX-30, Leopard 1 and M48/M60 MBTs. On the ENGESA Ororio MBT three VS580s have been installed (commander, gunner, thermal).

Officine Galileo and SFIM have established an agreement to design and produce a VS580 derivative named PSPC, dedicated for use on the C1 Ariete MBT, B1 Centauro tank destroyer and VCC-80 MICV.



The models available include the following:

- (a) VS 580 Multi-role a panoramic sight with complete target processing capability (including a stabilised laser rangefinder)
- (b) VS 580 VICAS for the tank gunner to use in firing-on-the-move and fitted with a laser rangefinder

All the VS 580 sight variants comprise three subsystem assemblies:

- (a) a sight upper assembly mounted on the turret roof which contains the gyrostabilised panoramic sight head and its related electronics
- (b) an intermediate assembly which joins the upper unit to the lower telescopic assembly and houses the laser rangefinder
- (c) a lower telescopic assembly within the turret confines containing the optical viewing system and associated hand controls, electrical circuits and sight stabilisation equipment.

SPECIFICATIONS

WEIGHTS
electronics unit 12 kg
DIMENSIONS

Sight

height 768 mm
width (between handles) 304 mm
ELEVATION RANGE ±35°
AZIMUTH RANGE 360° (without limit)

Day channels

Laser rangefinder

WAVELENGTH 1.064 μm or 1.54 μm

Status: In production. By early 1993 some 800 had been completed with a further 900 on order. Known applications include Italy (C1 Ariete MBT, B1 Centauro 8×8 tank destroyer and VCC-80 infantry fighting vehicle). Brazil (Osorio P2), South Korea (Type 88 MBT), the United Arab Emirates (OF-40 MBT) and UK Challenger 2.

Manufacturer: SFIM Industries, 13 avenue Marcel Ramolfo Garnier, F-91344 Massy Cedex, France.

Telephone: (1) 69 20 88 90 Telex: 602164 Fax: (1) 69 20 28 13

SFIM VS 580 Tank Commander's Gyrostabilised Sight

SFIM VS 580-30 Gyrostabilised Thermal Sight

Development/Description

The VS 580-30 thermal sight is part of the VS 580 panoramic sight family (qv) and is designed to be integrated into the fire control systems of MBTs or self-propelled anti-aircraft vehicles to detect, identify and fire at thermally imaged targets.

It can be used by both the vehicle commander and gunner and can either be permanently mounted on the turret roof or, when fully armoured, attached to the outside of the turret for temporary missions.

Depending on user requirements and the type of armament to be slaved, several models of the VS 580-30 are available including the VS 580-30

Casimir.This is the VS 580-30 fitted with the TRT Castor 8-13 μm dual field thermal imaging camera. This has been installed on the Osorio MBT. Weight is 90 kg with the head having instantaneous field-of-view of 2.5° \times 1.6° (narrow field) or 5° \times 3.3° (wide field) over the stated MBT elevation and azimuth ranges.

The thermal image is displayed either on monitors inside the vehicle or on micro-monitors whose images are projected into the day-time optics of the sight.

The sight can also be coupled with the VS 580 day-time family variants to provide a comprehensive observation/target engagement system.

SPECIFICATIONS

ELEVATION RANGES

MBT fit ±35°

-10° to +60° 360° (without limit) AA vehicle fit AZIMUTH RANGE 8-13 µm

CAMERA WAVEBAND **DETECTION RANGES**

(depending upon transmission conditions)

tank 6000 m 9500-12 500 m aircraft helicopter 6500 m personnel 3500 m

Status: Production. In service with several unspecified countries.

Manufacturer: SFIM Industries, 13 avenue Marcel Ramolfo Garnier,

F-91344 Massy Cedex, France.

Telephone: (1) 69 20 88 90 Telex: 602164 Fax: (1) 69 20 28 13



SFIM VS 580-30 Gyrostabilised Thermal Sight

SFIM Sirius Daytime Thermal Panoramic Stabilised Sight

Development/Description

The Sirius sight is a derivative of the VS 580 and keeps the same mechanical interfaces. It is designed as a panoramic stabilised sight with full direct viewing capability and long-range thermal imager. Due to its VS 580 generic design qualities the Sirius maintains similar stabilisation and line-of-sight accuracy. Built-in Test is fitted and the sight is capable of autotracking.

The Sirius sight comprises the following sub-systems:

- (a) Sight upper part this is identical to the VS 580 upper part but with a new optical coating and dedicated window
- (b) Thermal module this houses a German Steinheil sprite thermal imager fitted with a derogation prism
- (c) Telescope this has the same human ergonomic factors as the standard day VS 580 sight
- (d) Electronics box this has the same electrical interface to the fire control system as fitted to the standard day CPS.

Due to the architecture of the Sirius the thermal imager is located within the turret, which provides reduced vulnerability (the stabilised head can be far smaller than a FLIR located in the stabilised head).

SPECIFICATIONS

AZIMUTH full unlimited panoramic deflection

ELEVATION RANGE -35° to +35° STABILISATION AND SLAVING 0.1 mil

SLEWING RATE 0.1 to 1000 mil/s **DETECTION RANGE** 5800 m plus RECOGNITION RANGE 2400 m plus

FIELD-OF-VIEW

16° and 5° direct view optic thermal channel

Status: Ready for production.

Manufacturer: SFIM Industries, 13 avenue Marcel Ramolfo Garnier,

F-91344 Massy Cedex, France.

Telephone: (1) 69 20 88 90 Telex: 602164 Fax: (1) 69 20 28 13



SFIM Sirius daytime thermal panoramic stabilised sight

SFIM VISAA Stabilised Anti-aircraft Sight

Development/Description

The Viseur Anti-Aérien (VISAA) anti-aircraft sight has been evolved from the SFIM VS 580 sight for use on anti-aircraft turrets. It provides target detection and observation at very long range, target recognition and identification up to 5000 m, line-of-sight for firing and optional target parameter acquisition.

For a one-man turret SFIM suggests that a VISAA sight with all options is installed, while for larger two-man turrets the commander would have a standard VISAA sight to acquire and identify the targets and the gunner the all-option version to engage them.

The available optional extras include the installation of an automatic tracking system using a built-in camera system and the installation of a laser rangefinder module.

In all-sight versions three operating modes are available for use:

- (a) independent mode for observation with the operator using the panoramic capabilities of the sight at a magnification of x 3 to observe in all directions
- (b) servoed slave mode if the vehicle is fitted with a search radar
- (c) master mode for transmission of target data to the vehicle fire control system. The target is initially tracked by the operator using either the control joystick or the optional automatic tracking system. The built-in gyroscopic reference unit makes the operation independent of the turret movements.



Target identification is achieved by switching to the \times 10 magnification channel of the sight. If a laser rangefinder is fitted then this is used to continuously provide accurate target range values to the fire control system while the gyro delivers the target tracking rates. The target parameter data is used by the ballistic computer to update the required aiming corrections for the weapon(s) so they can be fired at the target and give a high probability of a hit.

SPECIFICATIONS

 ELEVATION RANGE
 -20° to +70°

 AZIMUTH RANGE
 360°

 MAX TRACKING SPEED
 110°/s

 MIN TRACKING SPEED
 0.2 mils/s

 FIELDS-OF-VIEW

 × 3 magnification
 16°

 × 10 magnification
 5°

LASER RANGEFINDER (optional)

WAVELENGTH 1.064 μ m MAX OPERATING RANGE 10 000 m ACCURACY ± 7 m

Status: Production. In service with Finland (Marksman turret) on T-55 MBT chassis and several unspecified countries.

Manufacturer: SFIM Industries, 13 avenue Marcel Ramolfo Garnier.

F-91344 Massy Cedex, France.

Telephone: (1) 69 20 88 90 Telex: 602164 Fax: (1) 69 20 28 13

SFIM VISAA sights on Marksman twin 35 mm air defence turret

SFIM HL-70 Commander's Gyrostabilised Panoramic Sight

Development/Description

The HL-70 gyrostabilised panoramic sight is in production by SFIM for fitting to the Leclerc MBT. It has a day optics system with switchable magnifications of $\times 2.5$ and $\times 10$, a light intensifier night optics module and a built-in laser rangefinder. In the commander's eyepiece are projected symbols which indicate the status of the tank, for example, type of ammunition, firing range, firing authorisation and so on. Optional equipment includes a TV camera to broadcast the image to the gunner, and for training a micromonitor display.

The sight is shrouded in separately controlled armour and uses a digital bus for electrical interfacing with the Leclerc weapon system.

Status: Production for the French Army (Leclerc MBT).

Manufacturer: SFIM Industries, 13 avenue Marcel Ramolfo Garnier, F-91344 Massy Cedex, France.

Telephone: (1) 69 20 88 90 Telex: 602164 Fax: (1) 69 20 28 13



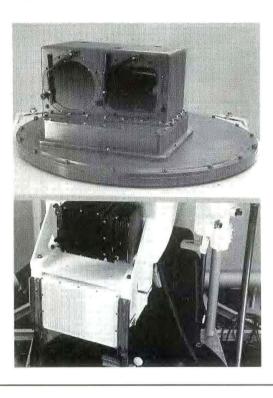
SAGEM DANAOS Day and Night Artillery Observer System

Development/Description

The DANAOS is designed as an optronic and inertial navigation day/night system for use on Field Artillery Forward Observation Vehicles. Its small, compact size allows it to be installed on light or heavy, tracked or wheeled armoured vehicles

DANAOS is able to undertake the following functions:

- (a) battlefield surveillance
- (b) target data acquisition the system automatically computes the position of the target selected by the operator



(c) target co-ordinate transmission - after validation by the operator, the position of the target can be automatically transmitted by the radio network to the artillery battalion headquarters.

The system comprises the following subsystems:

- (a) a day/night NBC compatible one-man 1 m LOA 20 Artillery Observation Cupola equipped with a day binocular device, a direct panoramic observation device, an 8-12 µm waveband thermal imager and a laser rangefinder
- (b) an SAGEM NSM 20 land navigation system (qv Land Navigation Systems section)

High level Built-In Test Equipment (BITE) is also integrated into the DANAOS assembly.

SPECIFICATIONS

ELEVATION RANGE -20° to +40° TRAVERSE 360° MAGNIFICATION (DAY OBSERVATION)

panoramic direct view binocular

FIELD-OF-VIEW (NIGHT OBSERVATION)

narrow

wide LASER RANGEFINDER WAVELENGTH STATION PLACING AND TARGET CO-ORDINATE DETERMINATION TIME TARGET LOCALISATION RANGE NORTH SEEKING ACCURACY NAVIGATION ACCURACY

TARGET CO-ORDINATES ACCURACY

2.5 and × 10

23 mil 100 mil

1.06 µm or eyesafe 1.54 µm

immediate 10 000 m

<1 mil

<0.2% of distance travelled 20 m

Status: Pre-production.

Manufacturer: Société d'Applications Générales d'Electricité et de Mécanique (SAGEM), Département Viseurs, 6 avenue d'Iéna, 75783 Paris Cedex 16. France

Telephone: (1) 40 70 63 63 Telex: 205255 F Fax: (1) 40 70 67 13

SAGEM DANAOS Day and Night Artillery Observer System

Sextent Avionique TMV 565 Monochrome TV Micromonitor

Development/Description

The TMV 565 micromonitor was developed under a DTAT/SEFT contract and adopted by the French Army under the designation RR189A. It is designed mainly for use on armoured vehicles and helicopters and has been tested on the HL60 sight for the Leclerc MBT and the Viviane roofmounted sight for the Gazelle helicopter.

The TMV 565 is fitted with a very small high performance display unit and can be coupled with various types of sensor. The TV standard is preselected at the factory stage. It is mounted in a single housing and features the following:

(a) a 23 × 21 mm flat screen on the front panel, with two positioning holes for alignment and four threaded holes for mounting

(b) a single MIL-STD-38999 connector on the rear panel for power supply, BITE result outputs, contrast and brightness control and video input. The micromonitor, as an option, can be fitted with an RS422 digital

SPECIFICATIONS

input/output.

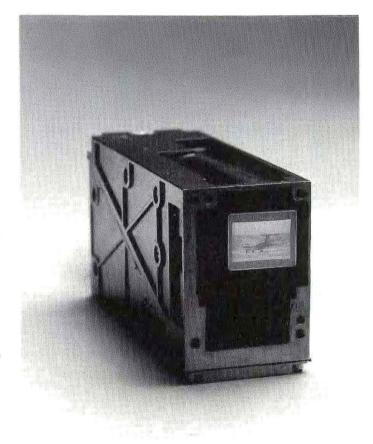
DIMENSIONS 155 × 56 × 83 mm less than 0.95 kg WEIGHT POWER SUPPLY 15-33 V DC

Status: Production. In service with the French Army.

Manufacturer: Sextant Avionique, 25 rue Jules Vedrines, F-26027 Valence

Cedex, France

Telephone: (33) 75 79 85 11 Telex: 345807 F Fax: (33) 75 56 43 37



Sextant Avionique TMV 565 monochrome TV micromonitor

SOPELEM M371 Episcopic Sight

Development/Description

The M371 periscope type sight has been developed to equip the vehicle commander's station in the TH 20 turret armed with a 20 mm cannon.

- It provides: (a) day observation
- (b) target designation



SOPELEM M371 Episcopic Sight

(c) fire control functions when engaging helicopters and slow flying aircraft (d) an emergency firing capability.

On the right side of the sight is the day vision path for engaging ground targets, whilst on the left side is the episcope path designed for observing, targeting and engaging helicopters and aircraft.

SPECIFICATIONS

WEIGHT	10 kg
ELEVATION RANGE	-15° to +55°
DAY CHANNEL	
magnification	× 6
field-of-view	10°
diopter range	-5 to $+2$
EPISCOPE CHANNEL	
magnification	× 1
fields-of-view	
one eye to 40 mm	
vertical	12°
horizontal	38°
both eyes	
vertical	32°
horizontal	77°

Status: Production. In service with the French Army.

Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimir Périer, PO Box 62, F-95872 BEZONS Cedex, France.

Telephone: (1) 34 23 30 00 Telex: 605793F Fax: (1) 34 23 33 50

SOPELEM OB-47 Tank Gunner's Night Sight

Development/Description

The OB-47 monocular, light intensification, passive vision, night sight can be fitted to the AMX-30 MBT to enable the gunner to aim and fire the main armament in darkness. It is usually associated with the OB-44 night observation binoculars and the M427-02 laser rangefinder sight.

The second-generation image intensifier tube fitted has automatic gain control and is of the micro-channel inverter type. Range is 1000 m with 10⁻³ lux illumination.

SPECIFICATIONS

Status: Production. In service with an unspecified country.

Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimir Périer, PO Box 62,

95872 BEZONS Cedex, France.

Telephone: (1) 34 23 30 00 Telex: 605793F Fax: (1) 34 23 33 50



SOPELEM OB-47 Tank Gunner's Night Sight

SOPELEM TJN2-71 Day/Night Optical Sight

Development/Description

The TJN2-71 periscopic sight is intended to be fitted both to cupolas armed with small calibre weapons and to larger-scale turret commander stations. For this a number of versions are available with different installation heights and elevation interfaces.

They all have an integrated prism head with three paths, $a \times 1$ magnification day periscope, $a \times 6.8$ magnification day sight and $a \times 4$ magnification night sight. The latter is fitted with a second-generation, 25 mm, inverter type, image intensifier tube that has a range of 500-1000 m, according to atmospheric conditions. The day and night sight paths also have a common eyepiece.

The sight can be used for day observation with a wide field-of-view and the possibility of use for defensive anti-aircraft fire, target designation and day and night firing.

Optional features include: a clear collimator in the periscope path; a declutchable elevation sensor in relation to the gun to allow for machine gun superelevation requirements; a vehicle commander's repeater unit with an optical module that receives an image from either another sight, such as a commander's TJN2-90, or a fire control system, such as the SOPTAC or Mithridat, and projects it onto the common eyepiece of the sight; and the capability to transfer the day and night path images to a second observer. Laser rangefinder and CAT are also proposed as options.

ELEVATION RANGE -15 to +55°

ALIGNMENT RANGE

+10 mil elevation azimuth +10 mil

Periscopic day sight

MAGNIFICATION FIELD-OF-VIEW horizontal vertical

200 RANGE about 1000 m

Daylight sight channel

MAGNIFICATION $\times 6.8$ FIELD-OF-VIEW

RANGE up to 2500 m Night sight channel

× 4 MAGNIFICATION FIELD-OF-VIEW 10°

RANGE 500 to 1000 m (according to atmospheric

 $\times 1$

430

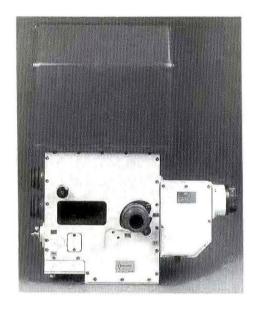
conditions)

Status: In production. In service with unspecified countries.

Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimir Périer, PO Box 62.

95872 BEZONS Cedex, France.

Telephone: (1) 34 23 30 00 Telex: 605793F Fax: (1) 34 23 33 50



SOPELEM TJN2-71 Day/Night Periscopic Sight for Turrets and Cupolas

SOPELEM-SOFRETEC CF 570 CCD Video Camera for Armoured Vehicles

Development/Description

The CF 570 is a militarised CCD video camera designed for mounting on a land vehicle viewfinder. It offers a high dynamic range output in the near infra-red (0.75 - 1.1 µm waveband region) and can be interfaced with stabilised view finding systems. A 17 mm CCD is fitted with field transfer.

SPECIFICATIONS

DIMENSIONS

height 110 mm length 75 mm diameter 188 mm WEIGHT WAVEBAND REGION SENSOR

NUMBER OF PIXELS STANDARDS

POWER SUPPLY

0.715 - 1.1 μm 17 mm CCD with field transfer

 576×550

CCIR 625 lines, 25 frames/s 28 V DC nominal

Status: Production as required.

Manufacturer: SOPELEM-SOFRETEC, SFIM Industries, 53 rue Casimer

Périer, PO Box 62, F-95872 Bezons Cedex, France.

Telephone: (33) 1 34 23 30 00 Telex: 605793F Fax: (33) 1 34 23 33 50

SOPELEM HL Daylight Panoramic 33 Observation Telescope

Development/Description

The HL 33 daylight panoramic observation telescope can be adapted to the roof of any fixed cupola or vehicle used or being designed for law enforcement and troop transportation. It can also be used as part of a light tank upgrade programme. The sight gives the vehicle commander a panoramic vision capability whilst under protection.

With the HL 33 there is no need for a rotating cupola. The elevation and azimuth are manually controlled.

The HL 33 has × 5 magnification (12° field-of-view) to magnification × 10 (field-of-view 6°) and 80 -130 mm episcope height (the distance between the telescope setting plane and the observation axis) options available.

Standard accessories include a camera outlet for viewing of images on a video recorder and an elastomer shroud over the episcope head (to protect against damage from ejected cartridge cases and vegetation).

A variant with an image intensifier night vision capability is also available.

SPECIFICATIONS (basic version)

MAGNIFICATION × 6 FIELD-OF-VIEW 100 **ELEVATION RANGE** -10 to +45° **AZIMUTH** 360° DIOPTER RANGE -4 to +2 EPISCOPE HEIGHT 130 mm

DIRECTION OF SIGHT visual indication of the direction with respect to the sighting reference ves

LASER PROTECTION

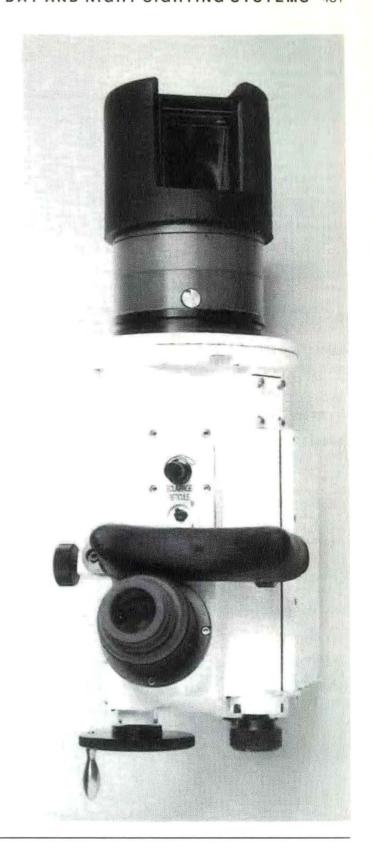
PERFORMANCE RANGES

detection 3000 m 2000 m recognition identification 1400 m

Status: Production as required.

Manufacturer: SOPELEM-SOFRETEC, 53 rue Casimir Périer, PO Box 62,

95872 BEZONS Cedex, France.
Telephone: (1) 34 23 30 00 Telex: 605793F Fax: (1) 34 23 33 50



SOPELEM HL 33 daylight panoramic observation telescope

SAT/Thomson-TRT Défense Athos Thermal **Imaging System**

Development/Description

The SAT Athos thermal imaging camera system has been adapted by SAT/Thomson-TRT Défense from the SMT modular thermal imaging range for incorporation into the gunner's day/night sight of the Leclerc MBT.

It consists of two modules integrated into the sight assembly. The camera operates in the 8-12 μ m waveband region of the spectrum and has two fields-of-view: $1.9\times2.9^\circ$ narrow and $5.7\times8.6^\circ$ wide. The thermal images received are transformed into video signal format and displayed on CRT monitors for the gunner and tank commander to view.

Status: On order for the French Army (for use on the Leclerc MBT).

Manufacturers: Société Anonyme de Télécommunications (SAT), 41 rue Cantagrel, F-75631 Paris Cedex 13, France.

Telephone: (1) 45 82 30 84 Telex: 250054

Thomson-TRT Défense, Optronic Division, rue Guynemer, BP55, F-78283 Guyancourt Cedex, France.

Telephone: (1) 30 96 70 00 Telex: THOM 616780F Fax: (1) 30 96 75 50

Thomson-TRT Défense CT-30 Thermal Fire Control System

Development/Description

The Thomson-TRT CT-30 is a day and night thermal fire control system suitable for use with all types of tank. It is fitted outside the turret in a case secured to the gun mantlet. It has high resolution, zoom and very long range aquisition capabilities that allow any tank equipped with the system to fire on mobile targets. The target speed is gained by image processing techniques. The commander and gunner have TV displays

The thermal imager uses the modules of the French Modular System (SMT) and operates in the 8 – 12 μm waveband region. The system uses a scanning serial parallel with cooled photovoltaic CMT sensors. Bifocal lens are fitted. The performance is stated to be equivalent to that obtained by a second generation MBT fire control system. The accuracy produced is better than 0.2 mrad with data taken from the associated laser rangefinder. tilt sensor, ambient temperature sensor and atmospheric pressure sensor package.

SPECIFICATIONS

WEIGHTS 20 kg camera system 60 kg WAVEBAND REGION 8-12 µm

AIMING ACCURACY better than 0.2 mrad

Status: Production as required.



Thomson-TRT Défense CT-30 thermal fire control system installed on an AMX-30 MBT for trials purposes

Manufacturer: Thomson-TRT Défense, Optronic Division, rue Guynemer, BP55, F-78283 Guyancourt Cedex, France.

Telephone: (1) 30 96 70 00 Telex: THOM 616780F Fax: (1) 30 96 75 50

Thomson-TRT Défense DIVT 13 Night Gunsight System

Development/Description

The Thomson-TRT DIVT 13 day/night passive observation and night firing Low-Light Level TeleVision (LLLTV) system was developed by the Direction Techniques des Armements Terrestres (DTAT) for use with the automatic fire control systems (COTAC) of the AMX-10RC, AMX-30 B2 and the prototype AMX-32 as night gunsights.

Although designed specifically for night use, the DIVT 13 can also be used in daylight as a gunsight. It is capable of engaging both fixed and moving targets in either situation.

The DIVT 13 consists of the following subsystems:

- (a) a CC8 television camera on a rigid casting with a large aperture, near infra-red night vision and automatic filters, shutter and diaphragm. The electronics fitted are associated with the camera's Supernoction image tube, the optical control circuits and the generation of the electronic sighting graticule (positioned for elevation and bearing by the fire control computer)
- (b) a BC458 tank commander's control unit



Main components of the Thomson-TRT Défense DIVT 13 night gunsight system with camera in the centre

- (c) two RR107 (TMV563) 700 points/line resolution display monitors with 110 mm diagonal screens (one for the commander and the other for the gunner)
- (d) interconnecting cable set.

The DIVT 13 allows firing to be carried out at ranges of between 1000 and 1500 m on dark moonless nights, with no mist, and up to 3000 m on clear moonlight nights or by day. In misty conditions these ranges are reduced but in very cold (below 0°C) or in very dry weather (desert climates) these distances can be increased at night.

SPECIFICATIONS

DIMENSIONS camera 620 × 170 × 300 mm control unit 170 × 90 × 140 mm TV monitor (x 2) 260 × 140 × 100 mm WEIGHTS

camera 22 kg control unit 1.5 kg 3.8 kg TV monitor (x 2) POWER SUPPLY 20 to 30 V DC

SYSTEM OPERATING RANGE night position

10-4 Lux very dark night to 10+2 Lux dull day day position 10⁻¹ Lux moonlight to 10.5 Lux bright sunshine

Optical system FIELD-OF-VIEW 4×5.67 APERTURE f/1.5

FOCAL LENGTH 210 mm Electronics 625 lines, 50 half frames/s

SCANNING STANDARD **PHOTOCATHODE** RESOLUTION

Monitor

25 mm diameter, sensitivity 1 mA/Lux 600 points/line at 10⁻³ Lux

flat screen, 110 mm diagonal, 700 points/ line resolution

Status: Production. In service with the French Army (on AMX-10RC and AMX-30 B2 vehicles) and several undisclosed countries.

Manufacturer: Thomson-TRT Défense, Optronic Division, rue Guynemer, BP55, F-78283 Guyancourt Cedex, France

Telephone: (1) 30 96 70 00 Telex: THOM 616780 F Fax: (1) 30 96 75 50

Thomson-TRT Défense POLUX Light Optronic Processor

Development/Description

The POLUX light optronic processor is designed for use as a highly compact, vehicle-mounted real-time modular digital image processing system. It can be used to automate weapon system or fire control functions such as target acquisition, target recognition and tracking in order to reduce target engagement time and improve target locating accuracy.

It can be coupled to all types of video TV cameras (visible, infra-red, digital or analogue) and can be tailored to a specific application by software. The system comprises:

- (a) a key operated control unit
- (b) a metal enclosure which accommodates up to 12 function cards, nine for image processing and three for management and interfacing.

Each card performs a specific image processing function. The functions already available or being developed include:

- (i) image filtering improvement of signal-to-noise ratio
- (ii) detection automatic detection and location of contrasted objects

- tracing time stable numbering of detection objects
- tracking fine tracking of a target. Note: several targets can be tracked through the use of several tracking cards
- symbol generator insert keying of menus, text and graphic symbols into the image
- movement detection detection of mobile, contrasted objects with speed filters
- target recognition elimination of false alarms, detected and classified (for example, pedestrians, vehicles and so on)
- low-rate image transmission encoding of digital images for low-rate transmission via radio systems

detection of sky line - automatic detection of sky line in the image.

The modularity is obtained by assembling only the cards needed for a specific operational requirement and customising the application software of the management unit.

The POLUX configuration can be set up during use by the weapons system it is connected to and by its own control unit (by menu inserts keyed in the image). A list of typical vehicle and air defence system applications

APPLICATION

Artillery Observation Vehicle

MBT

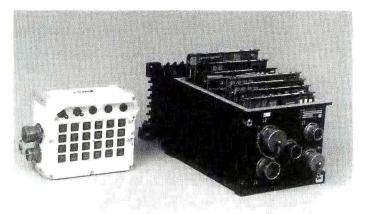
Ground-to-air and Surface-to-air

AUTOMATED OPERATIONAL MISSIONS

sector-based surveillance target designation aid (automatic detection, location and numbering of potential targets) object recognition low-rate image transmission

sector-based surveillance target designation aid (automatic detection/location/numbering) target monitoring weapon firing (target speed measurement and line-of-sight laying)

sector-based surveillance target designation aid (automatic detection/location/numbering) target monitoring missile firing (differential miss-distance)



POLUX can also be used on helicopters and as a site and frontier surveillance system. It has a dual sensor capability with parallel processing of two video signals selected from two digital video inputs and an analogue video input. A Built-in Test facility is fitted for fault detection and location at basic assembly level.

SPECIFICATIONS

DIMENSIONS 335 × 181 × 155 mm WEIGHT approx 8 kg POWER SUPPLY 28-30 V DC SYSTEM INTERFACES two RS422 links, one ARINC 429 link, two differential analogue output links, one 1553 link

(optional) VIDEO INPUTS/OUTPUTS

one CCIR analogue video input and output signal two digital 8-bit input video signals one digital output video

signal

20 MHz (1024 pixels/line)

1 to 512 pixels less than 20 msec (calc. frequency 50 MHz)

<1 pixel contrast, centre-of-gravity,

inertial

to object rotations, masking and motion size varies from 2 x 1 to 240 × 240 pixels manual or automatic, for

signal-to-noise ratio >4 up to four objects in parallel

up to 4800 bits/s over digital links

Image transmission LOW-RATE

FINE TRACKING

Tracing
OBJECT ACCURACY

AUTOMATIC ADAPTION

MODES

LOCK-ON

MAX DIGITAL VIDEO FREQUENCY

SIZE AND ATTRIBUTES OF OBJECTS

MAX NUMBER OF OBJECTS DETECTED

AUTOMATICALLY ADAPTING WINDOW

SIZE OF DETECTED OBJECTS

Automatic detection of contrasted objects

TIME REQUIRED TO CALCULATE POSITION,

IMAGE RESTITUTION RATE 0.5 s small image under resolved image 8.0 s 30 s full resolved image

Status: Production as required.

Manufacturer: Thomson-TRT Defénse, Optronics Division, rue Guynemer, BP55, F-78283 Guyancourt Cedex, France.

Telephone: (33) 1 30 96 70 00 Telex: THOM 616780F Fax: (33) 1 30 96 75 50

Thomson-CSF Defénse POLUX light optronic processor showing key operated control unit on the left and metal enclosure for control cards on the right

Thomson-TRT Défense Castor Thermal Imaging System for Armoured Vehicles

Development/Description

The Castor thermal imaging system is designed for use on armoured fighting vehicles. It is intended for observation and firing under all conditions of daylight, poor visibility and at night or for complete day/night fire control systems. It can be installed on:

- (a) tanks such as the M48, Osorio, T-series, AMX-30 B2 in either an armoured housing attached to the gun shield and coupled to the fire control system, with TV screen displays inside the turret for the commander and gunner (as on the AMX-30 B2 as the French Army DIVT 16 system), or inside the mantlet itself
- (b) reconnaissance vehicles such as the AMX-10 RC with the Castor unit within the turret
- (c) artillery observation vehicles such as the AMX-10 SAO and AMX-10 VOA. In the latter case the Castor unit is known under the French Army designation DIVT 17, is mounted outside the turret in an armoured housing and is slaved to the laser rangefinder's elevation system. A graduated graticule is provided with system coupled to the laser

- rangefinder and onboard computer to calculate the target's coordinates. The image is displayed on a TV monitor inside the turret
- (d) on turrets such as the Euromissile UTM 800 as mounted on VAB and MOWAG vehicles or the Giat Lancelot mounted on AMX-10P and MOWAG Piranha vehicles for launching HOT ATGWs
- (e) on other surface-to-surface or surface-to-air firing units for weapons such as the Thomson-CSF Crotale or Matra SATCP Mistral.

Castor is based on a modular concept. It operates in the 8-12 µm waveband region with the thermal radiation from the target being detected by a cooled HgCdTe photovoltaic assembly, serial-parallel scanned and then converted into a visible TV processed image for display on the standard monitor screen(s). If required, an additional control unit module can be fitted with the vehicle commander's unit acting as the master controller.

The system is available with either a monofocal or bifocal lens system giving a variety of fields-of-view. An electronic magnification capability (x 2) is also available. Target detection/recognition range of Castor is up to

A modular system for image processing, image detection and tracking is associated with the camera

WEIGHTS
optical unit 20 kg
electronic unit 9 kg
control unit 2 kg
DIMENSIONS

 optical unit
 452 × 181 × 302 mm

 electronic unit
 270 × 180 × 152 mm

 control unit
 105 × 155 × 135 mm

FIELDS-OF-VIEW

Status: Production. In service with the French Army (on AMX-30 B2 MBTs and AMX-10 VOA artillery observation vehicles) and other unspecified countries. The associated modular system for image processing will enter serial production in 1993.

Manufacturer: Thomson-TRT Défense, Optronic Division, rue Guynemer,

BP55, F-78283 Guyancourt Cedex, France.

Telephone: (1) 30 96 70 00 Telex: THOM 616780F

Fax: (1) 30 96 75 50



Giat Industries AMX-30 B2 MBT fitted with DIVT 16 thermal imaging system

GERMANY

Philips BM8025 Night Aiming and Observation System

Development/Description

The BM8025 passive night vision aiming and observation sight system was developed for use on the Marder 1 ICV and the Luchs reconnaissance vehicle.

It comprises the following subsystem assemblies:

- (a) an image intensifying sight with an adjustable monocular eyepiece which forms with the head mirror a fixed focus periscopic telescope. The light is controlled by an adjustable iris-diaphragm of the objective lens. A three-stage image intensifier tube with an 18 mm cathode is used with an adjustable sky shutter to prevent sudden light flashes from flares or weapons firing disturbing the operator's night vision capability
- (b) a single element HgCdTe infra-red thermal target indicator sensor which line-scans the full field-of-view of the image intensifying sight and reveals the true position of a detected target to the viewer by projecting a red flashing spot into the focal plane of the monocular eyepiece so that it is exactly superimposed on the light-intensified image of the scene
- (c) power supply unit which provides the various power requirements of the subsystems from the vehicle supply system
- (d) control unit to operate and control the thermal sensor and the flap protecting its optics.

SPECIFICATIONS

WEIGHTS
image intensifying sight thermal sensor 3.2 kg
power supply unit 5.5 kg
control unit 0.5 kg
DIMENSIONS

image intensifying sight 356 × 184 × 193 mm

thermal sensor length 320 mm diameter 122 mm

power supply unit $222 \times 100 \times 180 \text{ mm}$ control unit $116 \times 79 \times 80 \text{ mm}$ POWER SUPPLY 20-30 V DC vehicle system

Image intensifying sight

 MAGNIFICATION
 × 6

 FIELD-OF-VIEW
 5.6°

 DIOPTER RANGE
 -5 to +5

Thermal target sensor
WAVEBAND REGION 3-5 μm

FIELD-OF-VIEW horizontal 6° vertical 2°

Status: Production. In service with the German Army (on Marder 1 ICV and Luchs reconnaissance vehicles).

Manufacturer: Philips GmbH, Unternehmensbereich Systeme und Sondetechnik, Hans-Bredow-Strasse 20, Postbox 448740, D-2800 Bremen 44, Federal Republic of Germany.

Telephone: (421) 42871 Telex: 245268 Fax: (421) 404660

Atlas Electronik DMT 90 Dual Mode Tracker

Development/Description

The DMT 90 is an electronic image processing device that provides automatic acquisition and tracking of targets for a variety of armoured vehicle thermal imaging and TV systems in highly cluttered environments.

A self-contained microprocessor dynamically provides automatic selection of centroid or correlation processing. The input and output interfaces are programmable to cover the needs of different input and output formats. The unit contains its own symbol generator and a silhouette memory which allows the adaptation of the tracker even if symbology is present in the input video.

The main system functions include:

- (a) video processing using a direct interface with a wide variety of video formats
- (b) symbology that is logical generated together with a movable gate and aiming reticle, and a 512×1024 maximum resolution bit map

- (c) automatic Built-in Test facilities reporting to the submodule level
- (d) simultaneous control and correlation processing to reduce track error
- (e) centroid and correlation processing delays so that errors are available within 2 ms after end of respective track gate
- (f) selectable analogue (three) and digital (one) video input ports
- (g) two 16 bit ± 10 V and two 12 bit \pm 10 V A/D outputs
- (h) four differential 10 bit channel \pm 10 V D/A outputs
- (i) two RS422 and one RS232 serial I/O ports
- (j) one parallel 24 bit TTL level I/O.

Status: Production as required.

Manufacturer: Atlas Electronik GmbH, Sebaldsbrucker Heerstrasse 235, D-2800 Bremen 44, PO Box 44 85 45, Federal Republic of Germany. Telephone: (421) 457-0 Telex: 2457460 Fax: (421) 457 2900

Leitz Daylight/Thermal Imaging Alignment Collimator KTW 18m

Development/Description

The tripod-mounted dual facility KTW 18m collimator device allows armoured vehicle weapon systems/daylight and thermal imaging sighting optics to be calibrated to an accuracy of 0.1 mil (or 20 arc sec).



Leitz daylight/thermal imaging alignment collimator KTW 18m

It has side-by-side thermal imaging and day channel optical systems, with a graticule exchange facility in the latter that permits either the use of specialised graticules (eg Leopard 2, Marder 1/Luchs, Bradley M2) for point calibration or a universal graticule for parallel calibration. The short distance required in front of the weapon and the simple procedures involved allow calibrations to be undertaken in confined spaces and under conditions of poor visibility. The vehicle remains stationary, and its tilt is transferred to the collimator with an adjustable level. The parallelism between the daylight and thermal imaging collimator systems can easily be checked by the operator and adjusted if necessary.

SPECIFICATIONS

DIMENSIONS	
KTW 18m	335 × 335 × 320 mm
transporter container	600 × 600 × 500 mm
WEIGHT	

KTW 18m 18 kg transport container and accessories 22 kg tripod with carrying case 6 kg

Optical systems Daylight collimator

 LENS FOCAL LENGTH
 178 mm

 FIELD-OF-VIEW
 177.8 mil

 RESOLUTION
 ≤ 10 arc sec

Thermal imaging collimator

 WAVEBAND REGION
 8-14 μm

 LENS FOCAL LENGTH
 580 mm

 FIELD-OF-VIEW
 24 mil

 RESOLUTION
 ≤ 10 arc sec

Telescopic Sight
MAGNIFICATION × 4
FIELD-OF-VIEW 6°

Status: Production.

Manufacturer: Wild Leitz Systemtechnik GmbH, D-6330 Wetzlar, Federal Republic of Germany.

Telephone: (06641) 29-0 Telex: 4 83849 leiz d Fax: (06441) 29-2400

Leitz GPG-20 20 mm Synchroniser Test Device

Development/Description

The GPG-20 20 mm test device is used to test the synchronisation of the barrel of the weapon relative to the line-of-sight of the optical aiming devices of weapon systems. The optical principle used is collimation.

The GPG-20 consists of a mounting with integrated collimator and two lazy tongs with the optical deviating system. The adaptor, which is placed into the weapon's mounting instead of the barrel, holds the GPG-20. The adaptor may be modified to fit other weapons systems.

By spreading the two tongs, the adjustment cross of the collimator is imaged into the optics of the aiming device to be tested via the optical deviating system. In doing so, a maximum radius of 1.02 m may be bridged



Leitz GPG-20 20 mm synchroniser test device

between the centre of the barrel of the weapon and the aiming device. Friction couplings in the pivot bearings guarantee an accurate positioning. In order to converge the adjustment cross of the GPG-20 with the reticle cross-hair of the aiming device, the reticle may be adjusted for height and laterality and the collimator may be rotated around its longitudinal axis.

A built-in test system is part of the device and adjustment of the GPG-20 may be performed quickly and easily by the operating personnel without the use of any additional equipment.

SPECIFICATIONS

DIMENSIONS	
GPG-20	708 × 240 × 550 mm
GPG-20 container	$800 \times 400 \times 800 \text{ mm}$
weapon adaptor	650 × 70 mm diameter
weapon adaptor container	715 × 213 × 183 mm
WEIGHTS	
GPG-20	28 kg
GPG-20 container	27 kg
weapon adaptor	12 kg
weapon adaptor container	11 kg
LARGEST MEASURABLE	
SYNCHRONISATION ERROR	±7 mrad
MEASURING FIELD	40 mrad
FIELD-OF-VIEW	60 mrad
Optics	
COLLIMATOR FOCAL LENGTH	120 mm
LENS DIAMETER	38 mm
PARALLEL ADJUSTMENT OF	
COLLIMATOR PLUS	
LINE-OF-SIGHT	±0.05 mrad
PERMISSIBLE PARALLAXIS	±1 s

Status: Production. In service with undisclosed countries.

Manufacturer: Wild Leitz Systemtechnik GmbH, D-6330 Wetzlar, Federal Republic of Germany.

Telephone: (06441) 29-0 Telex: 4 83849 leiz d Fax: (06441) 29-2400

Leitz MODUS-P Optronic Panoramic Periscope

Development/Description

The MODUS-P optronic panoramic periscope is a modular, stabilised (in two axes) duospectral sensor periscope for use on armoured vehicles. The MODUS-P comprises the following subassemblies:

- (a) periscope electronics
- (b) digital controller
- (c) Digital Scan Converter (DSC)
- (d) power supply unit for thermal imager

The device is equipped with an ocular channel, two Charged Couple Device (CCD) cameras, a thermal imager, an eyesafe laser rangefinder and high resolution digital angle encoders for azimuth and elevation. These allow the periscope to perform the following functions in both daylight and darkness:

- (a) panoramic observation
- (b) target detection
- (c) target recognition
- (d) target identification
- (e) measuring target range (f) weapon aiming
- (g) terrain surveying

Both the CCD cameras permit a parallel representation of two visual fields for daylight operation. With limited daylight visibility and in darkness the thermal imager detects the natural thermal radiation from objects and converts it into a visible image. The laser rangefinder is used to measure the distance to the target within the limits 200 to 3995 m or up to 9995 m for terrain surveying purposes.

When coupled to the vehicle's fire control system the following functions can be performed by the MODUS-P:

- (a) communication with the fire control system by means of a digital SDLC
- (b) real-time determination of current angle position for azimuth and elevation
- (c) zero-point adjustment of the periscope angle values to the co-ordinate system of the fire control installation
- (d) operation as an aiming guide unit or in the lock-on mode by linking with the weapon system by means of an electric angle transmission chain

- (e) close-in of the weapon system on the line-of-sight
- (f) independent panoramic observation, even if the angle transmission chain fails
- (a) measurement of the target's range
- (h) field boresighting (an option)

SPECIFICATIONS (basic models)

DIMENSIONS	
periscope	360 × 360 × 810 mm
tank roof aperture	345 mm diameter
viewing assembly	260 × 220 × 150 mm
periscope electronics	440 × 210/90 × 220 mm
digital controller	370 × 125 × 190 mm
digital scan converter	$372 \times 281 \times 260 \text{ mm}$
thermal imager power supply unit WEIGHTS	$35\times170\times210~mm$

periscope 150 kg periscope electronics 20 kg

digital controller 5 kg digital scan converter 22 kg 16 kg thermal imager power supply unit POWER SUPPLY 24 V DC

Daylight optical operation data

MAGNIFICATION 20° wide field-of-view × 3 5° narrow field-of-view × 12

Aimina STABILISATION REFERENCE dynamically graduated 2-axis

gyroscope AIMING SECTOR

elevation/depression +20/-10° azimuth 360

Status: Prototype.

Manufacturer: Wild Leitz Systemtechnik GmbH, D-6330 Wetzlar, Federal

Republic of Germany.

Telephone: (06441) 29-0 Telex: 4 83849 leiz d Fax: (06441) 29-2400

Zeiss PERI-R17A1 Panoramic Periscope with Automatically Stabilised Line-of-Sight

Development/Description

The PERI-R17A1 commander's stabilised line-of-sight panoramic periscope is designed for use on MBTs, and has been adopted by the German Army for use on the Leopard 2 MBT. It is also capable of being retrofitted to the Leopard 1, the M48 and other tanks.

Any deviation in azimuth and elevation of the line-of-sight is caused by vehicle movement which is compensated for by the sight's own gyrostabilisation system. For panoramic viewing the head assembly itself is rotated, with a prism being used to enable the elevation of the viewing direction to be changed.

The sight can be used for general observation, target identification, tracking and engagement from a stationary or moving platform. Switchselectable magnifications of × 2 and × 8 are fitted. The PERI-R17A1 may be used either as an independent unit, or as a unit integrated into the vehicle's fire control system. Target assignment to the gunner is via analogue or digital servo loops. Standard features include a ready-to-fire indication and position indicator of the sight relative to the turret.

For maximum safety firing can only be initiated if the line-of-sight and the main armament alignment coincide. Aiming is via a standard NATO pattern reticule with adjustable brightness. Collimator markings are also used for boresighting, and there is also a direct viewing adaptor for thermal image projection (a feature used on the Leopard 2).

SPECIFICATIONS

× 8 magnification

DIOPTER RANGE

DIMENSIONS basic sight assembly 530 × 280 × 580 mm 450 × 200 × 210 mm electronics unit WEIGHT basic sight assembly 70 kg electronics unit 15 kg **ELEVATION RANGE** -13° to +20° TRAVERSE 360° POWER SUPPLY 27.5 V DC FIELD-OF-VIEW × 2 magnification 30

80

-4 to +4



Zeiss PERI-R17 panoramic periscope with gyrostabilisation

Status: Production as required. In service with the German Army (Leopard 2 MBT).

Manufacturer: Carl Zeiss Oberkochen, Postfach 1369/1380, D-7082 Oberkochen, Federal Republic of Germany

Telex: 71375133 Fax: (07364) 20-3855 Telephone: (07364) 20-2879

Zeiss PERI-RF Gyrostabilised Panoramic Periscope

Development/Description

The PERI-RF stabilised line-of-sight panoramic periscope is designed for use in the surface-to-air and surface-to-surface roles on armoured vehicles such as self-propelled anti-aircraft guns and IFVs. It can be used for panoramic observation, target observation, sighting, recognition, identification, designation, tracking and, in emergency situations, weapon aiming and firing

The main components of the PERI-RF are identical to those used in the PERI-R17 panoramic commander's sight in the Leopard 2 MBT. The sight can either be used autonomously or integrated into a fire control system. A position indicator is fitted which gives the sight a position relative to the turret. The operator's monocular eyepiece has a ready-to-fire indicator in its field-of-view, together with an adjustable brightness sighting pattern. The high resolution optics have switchable magnifications of x 2 for general surveillance use and × 8 for target recognition and tracking.

Optional equipment includes a TV camera adaptor for monitor mode, testing and training, a TV tracking system and a relay optic attachment for integrating other systems such as a thermal imager device.

SPECIFICATIONS

DIMENSIONS

sight assembly 310 × 330 × 560 mm electronics unit 450 × 210 × 200 mm

WEIGHTS sight assembly

electronics unit 17 kg **ELEVATION RANGE** -10° to +70° TRAVERSE 360° 24 ± 6 V DC POWER SUPPLY

FIELD-OF-VIEW

× 2 magnification 270 × 8 magnification 7.2° DIOPTER RANGE -4 to +4

Status: Ready for production.

Manufacturer: Carl Zeiss Oberkochen, Postfach 1369/1380, D-7082

Oberkochen, Federal Republic of Germany

Telephone: (07364) 20-2879 Telex: 71375133 Fax: (07364) 20-3855

Zeiss PERI-R17TW Gyrostabilised Panoramic Periscope with Day and Thermal Channels

Development/Description

The PERI-R17TW stabilised panoramic periscope sight for armoured vehicles is designed for use as a day and night observation, target identification and weapon firing system, this including both stationary and moving targets whilst its host platform itself is either stationary or moving.

The PERI-R17TW can be fitted to either new-build tanks or as a retrofit system to older MBT designs. Its modular design incorporates main subassemblies from the PERI-R17 panoramic telescope and WBG-X thermal imaging sights already in service with the Federal German Army

Muti-spectral wideband optics and high-power heat sensing 8-12 μm waveband detectors allow combat ranges to be obtained which are equal to those used on the present generation of thermal sights, such as fitted to the

Deviations of line-of-sight, from the nominal direction caused by vehicle movements, are compensated for by the sights stabilisation system. The PERI-R17TW can be used as an independent unit or slaved into the fire control system of an MBT. In the latter case the target is assigned to the gunner through analogue or digitised angle signals.

Optional features can include: line-of-sight control by tracker; an image analyser system; TV camera and push button sighting connection so the system can be settled on the line-of-sight of the selected vision channel.

SPECIFICATIONS

DIMENSIONS

periscope (with head rest) approx 825 × 230 × 530 mm periscope (without head rest) approx 825 × 230 × 390 mm approx 560 × 255 × 250 mm electronic unit **ELEVATION RANGE**

-13° to +20° TRAVERSE 360° 24 ± 6 V DC POWER SUPPLY EYEPIECE monocular DIOPTER RANGE -4 to +4

Day channel

FIELD-OF-VIEW × 10 magnification × 2.5 magnification 24°

Thermal channel

FIELD-OF-VIEW × 10 magnification $2.5^{\circ}\times5^{\circ}$

× 3.3 magnification $7.5^{\circ} \times 15^{\circ}$ 8-12 µm WAVEBAND REGION

Status: Field tested. Ready for production.

Manufacturer: Carl Zeiss Oberkochen, Postfach 1369/1380, D-7082

Oberkochen, Federal Republic of Germany

Telephone: (07364) 20-2879 Telex: 71375133 Fax: (07364) 20-3855

Zeiss PERI-ZL Gunner's Gyrostabilised Observation and Sighting Periscope with Integrated Laser Rangefinder

Development/Description

The PERI-ZL is designed to allow an MBT gunner to fire at a stationary or moving target whilst the vehicle itself is either stationary or moving.

The main subassemblies are:

(a) PERI-ZL sight assembly

(b) Commander's combined sighting telescope attachment

(c) Electronics Unit which performs voltage generation, control electronics and operation monitoring tasks

(d) Standardised Zeiss laser modules.

The PERI-ZL uses main subassemblies from the PERI-R17 stabilised periscope on the Leopard 2 MBT. Any deviations of the line-of-sight from the nominal elevation and azimuth directions caused by platform movements are compensated for by the sight's primary gyrostabilisation system.

The sight can be integrated into the MBT's fire control system where the ballistic computer determines the targets lead and superelevation angles on the basis of the range determined by the sight's laser rangefinder. Dynamic lead takes into account the relative movements of the vehicle and

The gunner uses a single handle to control the line-of-sight in elevation and azimuth. Displays are present for the range measured, multi-echo, firing and laser readiness. He has an observation channel with switchselectable magnifications of \times 3 and \times 10, a brightness control and a minimum range control.

The vehicle commander can use a light tube telescope attachment on the right side of the sight which has a monocular eyepiece combining the sighting telescope and display images seen by the gunner in his left and right eyepieces respectively.

SPECIFICATIONS

ELEVATION BANGE -12° to +20° TRAVERSE ±5°

FIELD-OF-VIEW

× 3 magnification 20° × 10 magnification 5.6° DIOPTER RANGE -4 to +4 DISPLAYS target range

multiple echo (yellow LED) laser readiness (green LED) firing readiness (red LED)

Laser rangefinder

Nd-YAG WAVELENGTH 1.064 µm **OPERATING RANGE** 400-10 000 m ACCURACY +10 m MINIMUM RANGE GATING 400-4500 m

Status: In service with the Swiss Army. In production.

Manufacturer: Carl Zeiss Oberkochen, Postfach 1369/1380, D-7082

Oberkochen, Federal Republic of Germany

Telephone: (07364) 20-2879 Telex: 71375133 Fax: (07364) 20-3855

Zeiss WBG-X Thermal Sight for Armoured Vehicles

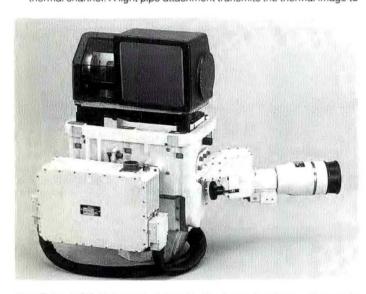
Development/Description

The WBG-X thermal sight uses the intrinsic thermal radiation of enabling vehicles and natural objects detection at long ranges, in poor visibility and by night. Their emission maxima at a temperature of 30°C occurs at a wavelength of 10 μm .

The WBG-X uses standardised US Army common modules, operating in the 8-14 μm waveband window, together with appropriate Zeiss afocals to achieve the required combat performance. The target aiming reticule is projected into the visual channel, and for adaption to eye sensitivity the red image provided by the system LED array is converted into a green image by an image intensifier tube.

The German Army has adopted the WBG-X for use on various vehicles:

(a) Leopard 2 MBT – in the application the thermal sight is a component of the gunner's EMES 15 primary sight assembly. The gunner views the thermal image through the biocular eyepiece of the EMES 15. The eyepiece need not be changed when switching from the day to the thermal channel. A light pipe attachment transmits the thermal image to



The Zeiss WBG-X thermal sight with the low-noise linear drive cooler combined with a dual FOV day sight packaged for the Luchs 8 \times 8 reconnaissance vehicle

- the PERI-R17 panoramic telescope of the commander. Thus, he can view either the thermal image or the panoramic visual image through the same eyepiece.
- (b) Leopard 1 MBT the thermal sight is part of the gunner's primary sight EMES 18. The thermal image is observed by the gunner through the binocular eyepiece. A light pipe transmits the thermal image to the commander's extra large FOV-ocular.
- (c) Marder 1 IFV the thermal sight is installed at the gunner's station in place of the PERI-Z11. The gunner observes through an eyepiece and the commander through a biocular whilst the sight visual day channel of the PERI-Z11 remains unchanged.
- (d) Luchs (8 × 8) reconnaissance vehicle the thermal sight is installed in the same way as in the Marder 1 IFV. In either case, integration of the thermal sight in the vehicle does not reduce the space available for the crew.
- (e) M113 AIFV with a two-man turret equipped with the WBG-X thermal gunner's sight and day sight, as with the Marder IFV.

SPECIFICATIONS

DIMENSIONS basic instrument $400 \times 130 \times 200 \text{ mm}$ power supply $405 \times 205 \times 205 \text{ mm}$

WEIGHTS

basic instrument 18 kg power supply 13 kg POWER SUPPLY 24 ± 6 V DC

IR channel FIELD-OF-VIEW

wide 15° × 7.5°
narrow 5° × 2.5°
WAVEBAND REGION 8-14 um

WAVEBAND REGION

DETECTOR TYPE
COOLING SYSTEM

WAVEBAND REGION

8-14 µm
HgCdTe, 120 elements
Stirling closed-cycle

FULL IMAGE FREQUENCY 25 Hz INTERFACE 2:1

Day channel MAGNIFICATION × 2 and × 6

MAGNITION X 2 and X 0

Status: Production. In service with the armies of Denmark, Germany, Netherlands, Norway and Switzerland.

Manufacturer: Carl Zeiss Oberkochen, Postfach 1369/1380, D-7082 Oberkochen, Federal Republic of Germany.

Telefunken Systemtechnik LLLTV Aiming and Observation System with IR Scanner Type PZB 200/IRS 100

Development

The LLLTV high-performance aiming and observation system with Infra-Red (IR) scanner combines the advantages of LLLTV and IR technology so that the thermal information detected by the latter is combined with the video signal supplied by the LLLTV, giving a congruently superimposed blinking infra-red signal on the monitor. The integrated IR signal allows even low contrast and camouflaged targets which can hardly be detected by the LLLTV to be observed.

The LLLTV system has been series produced and installed on Leopard 1, M48, OF-40, Centurion and Leopard 2 (as an interim fit) MBTs. It has also been field tested on AMX-30, TAM, lkv-91 and Kurassier tanks. Existing PZB 200 systems can easily be retrofitted with the IRS system.

Description

The complete system comprises the following subassemblies:

(a) Pick-up unit – which consists of two components, the LLTV camera and IR scanner, mounted coaxially to the main gun on special mounts attached to the gun shield. The PZB 200/IRS 100 system can be easily boresighted to the gun during the day or night.

The PZB 200 LLLTV camera picks up the night scene, intensifies it and supplies the scene as a TV picture via cable to the monitor(s) of the gunner and/or commander. For high aiming accuracy, a fixed optical reticule in the objective is projected with the scene image on to the first photocathode of the system pick-up tube combination and used as a reference for the subsequent manually or fire control computer-controlled electronically generated reticule. The camera is fitted with an automatic light control.

When the IR scanner IRS 100 is switched on, targets are detected by their thermal radiation differences in the 3-5 μm waveband region. The IR radiation picked up by the IR objective is depicted via an oscillating mirror on to a thermo-electrically cooled PbSe detector. The useful signals are then digitised, temporarily stored and converted into standard TV format. They are reconverted into analogue signals and superimposed on the LLLTV signal so that all the image scene information is congruently displayed on the monitor

- (b) Monitor which displays the LLLTV picture, thermal information and reticule
- (c) PZB 200 Control Unit which comprises the voltage supply, signal distribution, built-in test circuits and various control switches
- (d) IRS 100 Control Unit which comprises the built-in test circuit and various control switches
- (e) Super Elevation Device which generates the electronic reticule that is correspondingly adjustable to the ballistic data of the main armament. This reticule is moved by reference to the fixed optical reticule, and by manual input of target range (500-2000 m in steps of 100 m) and type of ammunition (standard APDS, HEAT and HEP/HESH rounds with option for any other type) into the device together with automatic information from the cant angle sensor. It is set accordingly in elevation and azimuth with automatic drift and parallax compensated. It also has various controls and switches for selection of ammunition type, target range and
- (f) Cant Angle Sensor which automatically transmits the ballistic correction value for the cant angle (up to +10°) of the vehicle to the Super Elevation Device, following alignment of its bubble level which is coupled to a potentiometer and which has its level axis orientated in parallel to the trunnion axis

0.4 to 0.8 um

- (g) interconnecting cable set
- (h) lens protection tube.

SPECIFICATIONS

MONITOR SCREEN SIZE

POWER SUPPLY

PZB 200 LLLTV

FOCUS RANGE

100 m to infinity

10⁴ to 10 lux

FIFI D-OF-VIEW

64 × 48 mils

WAVEBAND RANGE IRS 100 IR scanner

Status: Production as required.

Manufacturer: Telefunken Systemtechnik GmbH, Deutsche Aerospace AG – Optronik, Industriestr, 23-33, D-2000 Wedel (Holst), Germany. Telephone: (04103) 60-0 Telex: 2 189 520 Fax: (04103) 60 53 39



Telefunken Systemtechnik LLLTV aiming and observation system

ISRAEL

Elbit CELTICS Commander's Extended Link Thermal Imaging Combat Sight

Development/Description

The CELTICS system is designed for commander's using TOW ATGW missile thermal sights (AN/TAS-4, AN/TAS-4A), the long range AN/TAS-6 thermal night observation device or tank sight thermal elbows (eg of the 60 element detector, common module type).

It provides the commander with a high resolution CRT display of the images generated by the thermal imaging units. If required, it can also be configured to serve as an extended link for a day observation TV link, a thermal/TV tracker, an image transmission unit, a Vehicle-Mounted Display (VMD) or as a video command and control unit for a TOW platoon commander (whereby real-time images from several launcher units can be concentrated at his position/vehicle so that he can allocate and designate targets as they appear).

Status: Production. In service with the Israeli Army.

Manufacturer: Elbit Ltd, Advanced Technology Centre, POB 539, IL-31053 Haifa, Israel.

Telephone: (04) 315315 Fax: (04) 550002



Elbit CELTICS commander's extended link thermal imaging combat sight

Elbit 1 inch Bi-ocular Armoured Vehicle Military Display

Development/Description

The Elbit 1 inch bi-ocular vehicle display is a self-contained unit designed for use with FLIR/video systems. It supplies high brightness, high resolution magnified images from FLIR and TV camera inputs, superimposed with computer graphics and reticule images. The main system may be operated via the display control panels. The display image is magnified by $\times\,4.5.$

SPECIFICATIONS

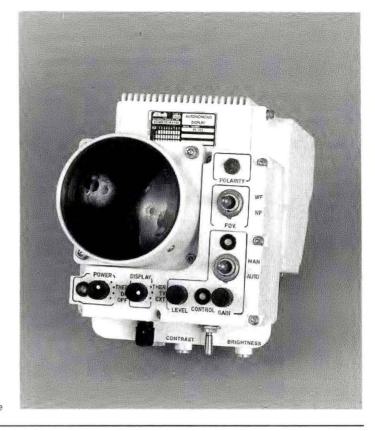
DIMENSIONS
WEIGHT
CRT TYPE
USEFUL SCREEN AREA
PHOSPHOR TYPE
LINEARITY DISTORTION
RESOLUTION
DISPLAY BRIGHTNESS
RASTER VIDEO INPUT
VIDEO BANDWIDTH
POWER SUPPLY

190 × 127 × 308 mm less than 5 kg 25.4 mm 71.1 × 53.3 mm (× 4.5 bi-ocular) PI green less than 4% MTF – 21% at 20 cy/mm 150 FL RS170 (525/60) or CCIR (625/50) 10 MHz with AGC and DC restoration 24 V DC Status: Production as required

Manufacturer: Elbit Ltd, Advanced Technology Park, PO Box 539,

IL-31053 Haifa, Israel.

Telephone: 972-4-315315 Fax: 972-4-550002 or 551623



Elbit 1 inch bi-ocular armoured vehicle military display from operators side

EL-OP Day/Night Range Sight (DNRS)

Development/Description

The DNRS is designed as a low-cost modular thermal sight assembly that is compatible with M36 periscope mountings on various types of AFVs.

It contains an integral laser rangefinder module and can be fitted with one of the following night vision options:

- (a) low-cost 60-element common module thermal imaging assembly
- (b) high performance forward looking infra-red module
- (c) second-generation tube image intensifier module.

SPECIFICATIONS

Day telescope sight

 DEPRESSION/ELEVATION
 -20° to +60°

 MAGNIFICATION
 × 8

 FIELD-OF-VIEW
 8°

Day unity sight

FIELD-of-VIEW

azimuth 25° elevation 14°

Thermal imaging sight

FIELD-OF-VIEW \times 8 magnification $1.1^{\circ} \times 2.2^{\circ}$ narrow \times 2.8 magnification $3.4^{\circ} \times 6.8^{\circ}$ wide

Laser rangefinder

 TYPE
 Nd-YAG

 WAVELENGTH
 1.06 μm

 OPERATING RANGE
 200-9995 m

 ACCURACY
 ±5 m

 DISCRIMINATION
 50 m

RANGE GATE min 300-5600 m

MULTIPLE ECHO LOGIC optional min range gate or first/last

Status: Production as required.

Manufacturer: EL-OP, Electro-Optics Industries Ltd, Advanced Technology Park, Kiryat, Weizmann, PO Box 1165, IL-76111 Rehovot, Israel. Telephone: (08) 386221 Telex: 381344 Fax: (08) 386237

EL-OP MSZ-2 Gunner's Day/Night Periscope

Development/Description

The EL-OP MSZ-2 periscope is a modular integrated electro-optical fire control system for use by gunners on tanks and other AFVs such as the M24, M41, M48, M50 Sherman, M51 Sherman, Centurion, Saladin and Scorpion. It is used to upgrade the ranging and aiming capabilities of the vehicles by incorporating a day and night laser rangefinder with enhanced magnification and passive night vision capabilities into a relatively small size.

Two basic versions are available, with a number of intermediate variants between them in terms of capabilities also available. The simplest model consists of the EL-OP mini-laser rangefinder with a \times 1 magnification prism, both of which permit operations during daylight, and a night elbow. The prism unit is fully interchangeable with the passive imaging night elbow so that observation, aiming and rangefinding are possible in darkness. The elbow contains a standard NATO graticule (or any other required graticule) and a laser aiming mark for night rangefinding. The graticules are projected and collimated on the image intensifier tube to give the accuracy needed for aiming and rangefinding at night.

The most sophisticated version is a fully computerised model with the same basic systems but also a ballistic computer, sensors and a rotating wedge module for the automatic insertion of ballistic compensation data, providing a single higher accuracy graticule and full fire control system solutions in a faster reaction time.

The day/night periscope for a vehicle commander is identical to the gunner's model but is designed to utilise $a \times 8$ magnification day elbow in place of the mini-laser.

SPECIFICATIONS

Unit

Prism device

MAGNIFICATION × 1

FIELD-OF-VIEW
horizontal 40°
vertical 14°

Passive night vision elbow

MAGNIFICATION \times 7.2 ±10% FIELD-OF-VIEW 7.5°

RESOLUTION 0.4 mrad at 10³ FL

DISTORTION 8% max POWER SUPPLY

regular 24 V DC vehicle emergency two 1.5 V batteries

Daylight system and mini-laser rangefinder

 MAGNIFICATION
 × 8

 OPERATING RANGE
 300-9900 m

 RANGE ACCURACY
 ±10 m

 FIELD-OF-VIEW
 8°

 RESOLUTION
 0.03 mrad

Daylight elbow

 MAGNIFICATION
 × 8

 FIELD-OF-VIEW
 8°

 RESOLUTION
 0.3 mrad

 POWER SUPPLY
 24 V DC vehicle

Status: In production. In service with the Israeli Defence Force and other unspecified countries

Manufacturer: EL-OP Electro-Optics Industries Ltd, Advanced Technology Park, Kiryat Weizmann, PO Box 1165, IL-76110 Rehovot, Israel. Telephone: (08) 386221 Telex: 381944 Fax: (08) 386237



EL-OP MSZ-2 gunner's day/night periscope showing modular construction of system

EL-OP Passive Night Vision Elbow Telescope

Development/Description

The EL-OP passive night vision elbow is a second-generation image intensifying system designed to replace the now obsolete infra-red night elbow used with the M32 tank periscope. It fits into the right-hand opening of the M32 head assembly and incorporates night sighting and observation capabilities as an integral part of existing tank's periscope fire control system



EL-OP passive night vision elbow telescope which is a direct replacement for

The illuminated graticule which is projected with adjustable brightness on the image intensifier's photocathode can be boresighted to the gun on elevation and deflection by means of two thumbwheels

The elbow objective lens can be adjusted from a relatively short 50 m distance to infinity. The eyepiece has a diopter adjustable range from -4 to +4.

Power for the elbow is supplied either from the standard 24 V DC supply or by an emergency battery backup system which cuts in if the primary supply fails.

SPECIFICATIONS

MAGNIFICATION FIELD-OF-VIEW RESOLUTION (contrast = 1.0) 0.2 mil at 103 FL DISTORTION (0.8 field) 13% DIOPTER RANGE -4 to +4 OBJECTIVE LENS FOCAL RANGE 50 m to infinity POWER SUPPLY 24 V DC vehicle emergency two 2.7 V batteries

Status: Production. In service with unspecified countries.

Manufacturer: EL-OP Electro-Optics Industries Ltd, Advance Technology Park, Kiryat Weizmann, PO Box 1165, IL-76110 Rehovot, Israel. Telephone: (08) 386221 Telex: 381944 Fax: (08) 386237

RAFAEL NITE LITE Target Acquisition System

Development/Description

The NITE LITE target acquisition system has been developed by RAFAEL to provide real-time data of acquired stationary and moving targets under all weather, day and night conditions.

It is of modular construction, can be quickly deployed in the field, operates from a 24 V electrical supply and has a long range.

The NITE LITE system consists of an FLIR, laser rangefinder, goniometer, extensive data about the target including identification, azimuth, elevation, height, range and map co-ordinates.

All of the target information data is displayed on the computers LCD display and on the FLIR TV monitor.

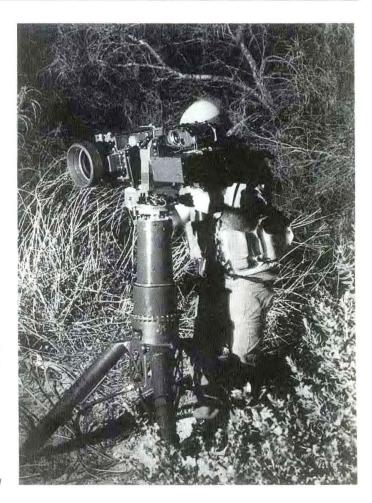
The electronics and computer unit is responsible for processing the data received from the goniometer, laser rangefinder and operator (via the keyboard) and displaying the results.

It has a data bank capable of containing 100 targets and is provided with a backup nickel cadmium battery to prevent loss of information in case of a power failure.

According to RAFAEL, the system is suitable for real-time target acquisition, field intelligence and fire control applications.

A tripod assembly guarantees the rigidity of the system; total weight of the complete system, excluding the nitrogen, is 45 kg. It is easily operated by two handles which enable smooth rotation of the goniometer and contain the controls for using the system. The tripod can be adjusted in height from 0.8 to 1.8 m.

The system is of modular construction so that it can be tailored to meet specific user and operational requirements. The thermal sensor can be replaced either by a telescope or a video camera.



Goniometer measuring accuracy

1 mil RMS (0-6399 mils) **AZIMUTH ELEVATION** 1 mil RMS (±300 mils) DISPLAY RESOLUTION azimuth and elevation 1 mil BACK UP MECHANICAL SCALE

Laser rangefinder

LASER TYPE Nd:YAG RANGE RESOLUTION 10 m RANGE ACCURACY ±10 m FIELD-OF-VIEW 1 pps TARGET INDICATION multiple

SPECTRAL BANDWIDTH 8-12 µm NARROW FIELD-OF-VIEW 1.7° × 1.3° IFOV (NFOV) 0.08 × 0.11 mrad2 WIDE FIELD-OF-VIEW $5.0^{\circ} \times 3.6^{\circ}$ NETD 0.1°C MRTD 0.5°C DISPLAY 525 lines/60 Hz 625 lines/50 Hz

Status: In production. In service with Israel Defence Forces and a number of undisclosed countries.

Manufacturer: RAFAEL, PO Box 2250/80, IL-31021 Haifa, Israel. Telephone: 972 4 794784 Telex: 471508 VERED IL

Fax: 972 4 794703

Rafael Periscopic Viewing Sight

Development/Description

The Periscopic Viewing Sight has been designed to provide Infantry Fighting Vehicles and APCs with an all-round observation facility over a wide range of elevations. It can be used either as an independent viewing device or as an aiming sight for various weapons and/or other equipment.

The periscope is equipped with five observation sights, with three for daytime use and two for the night-time. The operating procedure is manual through the use of folding handles. When these are closed up the traverse and elevation mechanisms are locked in position and when unfolded the mechanism brakes are released.

An azimuth indicator is fitted to show the operator the sight's position relative to the vehicle's centre line.

For certain uses a collimated aiming circle can be included as an option.

Status: Production.

Manufacturer: Rafael, PO Box 2250/80, IL-31021 Haifa, Israel.

Telephone: 972 4 794784 Telex: 471508 VERED IL Fax: 972 4 794703

SPECIFICATIONS

50 kg WEIGHT DIMENSIONS overall height 650 mm height over deck 400 mm envelope diameter 450 mm TRAVERSE 360° **ELEVATION** -25° to +75°

Day sights

FIELD-OF-VIEW × 1 magnification $35^{\circ} \times 18^{\circ}$

× 4 magnification 16° diameter (x 1 window with 26° × 11° FOV)

× 8 magnification 8° diameter (x 1 window with

26° × 11° FOV)

Passive Night Vision Elbows

FLBOW A

× 1 window with × 1 magnification

(VVS-2 type)

ELBOW B \times 1 window with \times 8 magnification

AMCORAM Ltd APS-3

Development/Description

The APS-3 is a manually operated 360° periscope system for armoured vehicle commander's. Through the use of simple folding mirrors the APS-3 allows a wide perspective view to the commander for controlling units on the battlefield up to the tank company level whilst under armour. When the mirror is folded, the traverse and elevation (from -20 to +70°) are locked in position.

SPECIFICATIONS

DIMENSIONS

required installation bore 272 mm height over deck 140 mm

height under deck

unfolded 180 mm folded 80 mm WEIGHT

30 kg in armoured steel in aluminium 15 kg **ELEVATION LIMITS** -20 to +70° TRAVERSE 360°

Status: Production as required.

Manufacturer: AMCORAM Ltd, 10 Hapeled Street, Industrial Zone,

IL-58811 Holon, Israel.

Telephone: (972) 3-805533 Fax: (972) 3-805536



AMCORAM APS-3 spherical vision periscope for armoured vehicles

ITALY

Alenia C215 Gunner's Articulated Telescopic Sight

Development/Description

The C215 was developed for use as part of the secondary direct fire control system of the OF-40 MBT and is mounted coaxially with the M114 telescope mount in a fixed position.

It comprises the following subsystems:

- head assembly which includes a monocular eyepiece, support arm and adjustable head rest
 - 2) articulated body unit in which the prisms are located
 - 3) objective tube assembly.

SPECIFICATIONS

WEIGHT 25 kg

DIMENSIONS 1200 × 178 mm

MAGNIFICATION × 8

FIELD-OF-VIEW 7.5° DIOPTER RANGE -4 to +4

Status: Production as required. In service with the United Arab Emirates.

Manufacturer: Alenia, Avionic Systems and Equipment Group, Viale Europe, I-20014 Nerviano, Italy.

Telephone: (0331) 587 330 Telex: 330675 AITNER

Alenia P186 Gunner's Telescopic Sight

Development/Description

The P186 telescopic sight has been designed to be part of the primary fire control system of the Palmaria 155 mm self-propelled howitzer.

It is fitted on a Bofors telescopic mount and is used for laying the weapon in azimuth and for indirect fire control.

The sight comprises the following subsystems:

- (a) head assembly with a right angle prism
- (b) top assembly
- (c) bottom assembly
- (d) monocular eyepiece with an Amici prism.

SPECIFICATIONS

WEIGHT 8 kg

 DIMENSIONS
 525 × 162 × 240 mm

 ELEVATION RANGE
 −34.5° to +19.5°

ELEVATION RANGE -34.5° AZIMUTH RANGE 360°

MAGNIFICATION × 4 FIELD-OF-VIEW 10°

Status: Production. In service with Libya and Nigeria.

Manufacturer: Alenia, Avionic Systems and Equipment Group, Viale

Europe, I-20014 Nerviano, Italy.

Telephone: (0331) 587 330 Telex: 330675 AITNER



Alenia P186 gunner's sight as installed in Palmaria 155 mm self-propelled artillery system

Alenia P204 Day/Night Gunner's Periscope

Development/Description

The P204 was developed for use as the gunner's periscope in the IVECO FIAT Type 6616 armoured car primary fire control system. It can also be adapted to replace M32, M34 and M36 periscopes installed in other types of armoured vehicles.

It is comprised of a main body and either a daylight elbow sighting periscope or a P194/P265 night elbow sight with a second-generation image intensifier tube. The body contains the head prism assembly, a unity power optical system and a mechanical lever linkage arrangement to the weapon.

SPECIFICATIONS

WEIGHT 12 kg
DIMENSIONS 466 × 295 × 202 mm

Day elbow MAGNIFICATION FIELD-OF-VIEW

DIOPTER RANGE P194 night elbow MAGNIFICATION

× 7 7.9°

 $\times 8$

-3 to +3

FIELD-OF-VIEW 7.9° DIOPTER RANGE -5 to +5

494 DAY AND NIGHT SIGHTING SYSTEMS / Italy

Status: Production. In service with the Italian Army.

Manufacturer: Alenia, Avionic Systems and Equipment Group, Viale

Europe, I-20014 Nerviano, Italy.

Telephone: (0331) 587 330 Telex: 330675 AITNER



Alenia P204 day/night gunner's periscope

Alenia P170L and P240L Day/Night Gunner's Laser Periscopes

Development/Description

The P170L and P240L are derived from the P204 sight to meet the technical requirements of observing, aiming and laser ranging in day and night conditions.

The only difference between the two periscopes is that the position of the weapon linkage lever is on the right in the P170L and on the left in the P240L.

(a) periscope body assembly with a head prism, \times 1 magnification optical window and weapon linkage unit

(b) daylight elbow which includes the objective, right angle prism, reticle assembly, eyepiece laser assembly, laser optics and display module. The actual daylight elbow itself is fully interchangeable with the passive night vision elbow.

The integrated Nd-YAG 1.064 μm wavelength laser transceiver module uses a common aperture arrangement for the transmitted pulse, received echo and the visual image channels.

SPECIFICATIONS

WEIGHT 15 kg

 DIMENSIONS
 295 × 202 × 530 mm

 ELEVATION
 -177 to +1245 mils

POWER SUPPLY 24 V DC

Daylight elbow

 MAGNIFICATION
 × 8

 FIELD-OF-VIEW
 160 mils

 UNITY POWER FIELD-OF-VIEW
 462 mils

 vertical
 177 mils

 DIOPTER RANGE
 -3 to +3

Passive night vision elbow

 MAGNIFICATION
 × 7

 FIELD-OF-VIEW
 147 mils

 DIOPTER RANGE
 -5 to +5

Laser rangefinder module



Alenia P240 day/night gunner's laser periscope

Status: Production as required. In service with undisclosed countries.

Manufacturer: Alenia, Avionic Systems and Equipment Group, Viale

Europe, I-20014 Nerviano, Italy.

Telephone: (0331) 587 330 Telex: 330675 AITNER

Alenia P223 Vehicle Commander's Night Vision Periscope

Development/Description

The P223 commander's passive night vision sight was developed for use on APCs, IFVs and other armoured vehicle types. It can also be retrofitted to the earlier models of MBTs and is fully interchangeable with all European and American daylight periscope systems.

It consists of the following subsystems:

(a) head assembly with a right angle prism

(b) main body assembly which contains the objective lens, sight graticule, binocular eyepiece unit, the system electronics and a second generation image intensifier tube

Range of the image intensifier in starlight is up to 800 m, depending upon the conditions.

SPECIFICATIONS

WEIGHT 7.5 kg MAGNIFICATION $\times 3$ FIELD-OF-VIEW horizontal 16° vertical 15

Status: Production. In service with the Italian Army.

Manufacturer: Alenia, Avionic Systems and Equipment Group, Viale Europe, I-20014 Nerviano, Italy.

Telephone: (0331) 587 330 Telex: 330675 AITNER

Alenia P265IL Passive Night Vision Elbow

Development/Description

The P265IL night elbow aiming periscope has been designed to be directly interchangeable with the daylight elbow of the P170L/P240L/P240 periscopes and can also be used to replace the infra-red elbow used in the M32 and M36 MBT periscopes.

The main components comprise:

(a) elbow assembly with the objective, high reflectance mirror, a 25 mm second-generation image intensifier tube and eyepiece unit

(b) reticle projection device assembly which includes an objective, mirror, pentaprism, reticle unit and a high emitter diode.

Range of the image intensifier in starlight conditions is 1300 m with the projected reticle intensity being adjustable to suit the conditions. If the main power supply is interrupted for any reason then a 3 V DC lithium battery automatically cuts in.

Status: Production as required. In service with undisclosed countries.

Manufacturer: Alenia, Avionic Systems and Equipment Group, Viale Europe, I-20014 Nerviano, Italy.

Telephone: (0331) 587 330 Telex: 330675 AITNER



Alenia P265IL passive night vision elbow

SPECIFICATIONS

WEIGHT 8 kg

DIMENSIONS $345\times175\times278~mm$

MAGNIFICATION × 7 FIELD-OF-VIEW 8.3

RESOLUTION (USAF target 85%

contrast, 90% reflection) 1 lux

0.3 mil 10 lux

FOCAL RANGE 20 m to infinity DIOPTER RANGE -5 to +5POWER SUPPLY 24 V DC **EMERGENCY BATTERY** 3 V DC lithium

Alenia V 200 Vision Block

Development/Description

The V 200 vision block is designed for general observation use from the inside of M113 APCs or other troop carrying armoured vehicle types. It is able to survive a direct penetration hit by standard NATO 7.62 mm ammunition and can offer protection to the observer against all types of small arms actions.

SPECIFICATIONS

WEIGHT 10 kg

DIMENSIONS 187.5 × 291 × 114 mm

MAGNIFICATION $\times 1$ FIELD-OF-VIEW 90 horizontal vertical 300

Status: Production as required. In service with the Italian Army and other unspecified countries

Manufacturer: Alenia, Avionic Systems and Equipment Group, Viale

Europe, I-20014 Nerviano, Italy,

Telephone: (0331) 587 330 Telex: 330675 AITNER



Alenia V 200 vision block

Officine Galileo OG-PO7 Periscope Sight

Development/Description

The OG-PO7 has been developed to fulfil the requirement for an observation/ aiming periscope sight to be used in light armoured vehicles where the crew accommodation does not rotate with the turret.

The scanning movements of the line-of-sight are given in traverse by the rotation of the turret and in elevation by a mechanical connection which transmits the angle attained by the armament to the prism of the periscope.

Two variants are available: the monocular eyepiece OG-PO7 and the binocular eyepiece OG-PO7B.

SPECIFICATIONS

(OG-PO7B version)

WEIGHT 19 kg

DIMENSIONS 550 × 290 × 246 mm

ELEVATION RANGE -10° to +50° AZIMUTH RANGE 360°

MAGNIFICATION × 1
FIELD-OF-VIEW 44°

Status: Production. In service with the Italian Army.

Manufacturer: Officine Galileo SpA, Via Einstein 35, I-50013 Campi

Bisenzio, Florence, Italy.

Telephone: (55) 89501 Telex: 570126 Fax: (55) 8950603



Officine Galileo OG-P07 periscope sight

Officine Galileo OG-P20 Periscope Sight

Development/Description

The OG-P20 has been developed to fulfil the requirement for an observation/ aiming periscopic sight to be used in light armoured fighting vehicles where the crew accommodation does not rotate in concert with the turret.

Monocular or binocular versions are available and comprise a single sight assembly with a rotating head prism and an electronics box connected by cables.

SPECIFICATIONS

DIMENSIONS 680 × 320 × 340 mm

ELEVATION RANGE -10° to +60°

AZIMUTH RANGE 360°

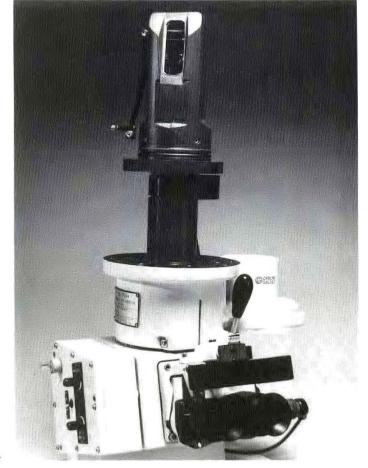
FIELDS-OF-VIEW
× 1.5 magnification 28°
× 4.5 magnification 10°

Status: Production. In service with the Italian Army.

Manufacturer: Officine Galileo SpA, Via Einstein 35, I-50013 Campi

Bisenzio, Florence, Italy.

Telephone: (55) 89501 Telex: 570126 Fax: (55) 8950603



Officine Galileo OG-P20 periscope sight

Officine Galileo OG-P101 Periscope Sight

Development/Description

The OG-P101 observation/aiming sight is designed to replace, with suitable modifications, the M32, M34 and M36 periscopes on armoured fighting

For night vision and firing it uses a second-generation light intensifier tube assembly.

SPECIFICATIONS

DIMENSIONS 470 × 205 × 295 mm **ELEVATION RANGE** -10° to $+70^{\circ}$

FIELDS-OF-VIEW × 1 magnification 26° × 10° × 8 magnification

Status: Production. In service with the Italian Army.

Manufacturer: Officine Galileo SpA, Via Einstein 35, I-50013 Campi

Bisenzio, Florence, Italy.

Telephone: (55) 89501 Telex: 570126 Fax: (55) 8950603



Officine Galileo OG-P101 periscope sight

Officine Galileo Vehicle Commander's SP-T-694 Gyrostabilised Panoramic Day/Night Sight

Development/Description

The SP-T-694 day/night binocular sight has been developed for use in the vehicle commander's station of the Otomatic 76 mm self-propelled antiaircraft gun, the IVECO FIAT B1 wheeled tank destroyer and the OTO Melara/IVECO FIAT C1 MBT to carry out wide-area surveys of the battlefield, supervise the gunner's operation, slave the sight's line-of-sight to that of the gunner's optics and provide an alternate firing station for the main



All the sight operations are controlled by a 16-bit microprocessor. Functions can be expanded up to the computation of azimuth and elevation lead angles as an option to the gunner's fire control system and allow the commander to control and fire the main armament whilst the vehicle is

The sight interface is both digital and analogue to enable system integration

with most modern types of fire control systems.

The night vision capability is provided by a third-generation image intensifier tube assembly. Daylight vision is provided by dual magnification narrow/wide field-of-view optics.

SPECIFICATIONS

ELEVATION RANGE -10° to +60° AZIMUTH RANGE 360° Daylight channel

FIELDS-OF-VIEW

× 2.5 magnification 20° × 10 magnification DIOPTER RANGE -5 to +5

Night channel MAGNIFICATION $\times 6$ FIELD-OF-VIEW 80

Status: Production.

Manufacturer: Officine Galileo SpA, Via Einstein 35, I-50013 Campi

Bisenzio, Florence, Italy.

Telephone: (55) 89501 Telex: 570126 Fax: (55) 8950603

Officine Galileo Vehicle Commander's SP-T-694 Gyrostabilised Panoramic

Officine Galileo VIR52 Gunner's Night Vision Periscope

Development/Description

The VIR52 night vision periscope assembly has been designed to be fully interchangeable with daylight periscope systems already mounted on tanks and armoured fighting vehicles to provide observation and aiming capabilities in any ambient light conditions.

It combines a 3-5.5 µm waveband region PbSe infra-red thermal imaging detector unit with a second generation image intensifier tube assembly, providing a comprehensive long range detection and engagement capability

even in conditions of fog, mist or low light contrast and against traditional camouflage techniques. If required, the thermal imaging can be switched off so as to optimise the resolution and definition capacity of the image intensifier

Typical detection range of a large target is 1200 m with it becoming recognisable at 800 m.

WEIGHT 13.5 kg

DIMENSIONS 348.5 × 262.5 × 226.2 mm

MAGNIFICATION × 3
DIOPTER RANGE -4 to +4
THERMAL IMAGING

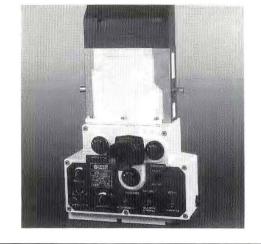
WAVEBAND 3-5.5 μm

Status: Production. In service with the Italian Army.

Manufacturer: Officine Galileo SpA, Via Einstein 35, I-50013 Campi

Bisenzio, Florence, Italy.

Telephone: (55) 89501 Telex: 570126 Fax: (55) 8950603



Officine Galileo VIR52 Gunner's Night Vision Periscope

Officine Galileo Thetis Thermal Tank Infra-red System

Development/Description

The Thetis system is designed to provide tanks and combat vehicles with a modular night sighting for use either as the vehicle's main night fire control system or as a night sight upgrade to an existing fire control system. Thetis can also be used in poor visibility and battlefield smoke conditions.

Thetis has been installed on the OTO Melara OF-40 MBT and is under evaluation on the Leopard 1 MBT of the Italian Army. The main components are:

- (a) Infra-red module which is installed externally on the vehicle gun mantlet. It includes the thermal imaging unit and relevant cooling system
- (b) Gunner/Commander's monitors internally installed at the gunner's and commander's stations to present the IR image and aiming reticle
- (c) Control panel for remote control of the IR imager and reticle, and data introduction
- (d) Digital 16-bit ballistic computer computes the lead angles and automatically introduces them on the aiming reticle on the basis of ammunition select and target distance. The ballistic data can either be manually introduced or received from an external source (for example, laser rangefinder). If Thetis is coupled to an existing fire control system the line-of-sight will be laid using the existing lead angle computation system.



Officine Galileo Thetis tank infra-red system installed on an OF-40 MBT *

SPECIFICATIONS Infra-red module

 DIMENSIONS
 150 × 200 × 350 mm

 WEIGHT
 9 kg (with telescope)

 MAGNIFICATION
 × 4 and × 12

 FIELD-OF-VIEW
 6.6 × 3.3° and 2.2 × 1.1°

 WAVEBAND REGION
 8-14 μm

 COOLING SYSTEM
 closed cycle

 AIMING RETICLE
 mobile with electric control

Control panel
BASIC FUNCTIONS

FIRE CONTROL SYSTEM FUNCTIONS

ammunition selection, target distance AUT/MAN selection, target distance introduction,

on/off, reticle alignment, magnification

reticle brightness regulator, contrast/

other commands according to general system configuration

regulator, bright/dark inversion

Ballistic computer
TYPE 16-bit digital CPU

Status: Production as required.

Manufacturer: Officine Galileo SpA, Via Einstein 35, I-50013 Campi Bisenzio, Florence, Italy.

brightness

Telephone: (55) 89501 Telex: 570126 Fax: (55) 8950603



Officine Galileo Thetis thermal tank infra-red system installed on a Leopard 1 MBT

Officine Galileo Madis Sighting and Drive System

Development/Description

The Madis sighting and drive system was developed for the OTO-Melara SIDAM 25 self-propelled anti-aircraft our system. Composed of three modular units, the system can also be installed in other anti-aircraft vehicles either in total or in part.

The modules are:

(a) daylight optical head which contains the visual telescope. This is selfstabilised by a gyro directly coupled to the line-of-sight to allow for sighting operations on the move. The unit can also operate without the gyro as a servoed optical sight.

Provision is made for compensation of image rotation due to the azimuth

The head can also accommodate a laser rangefinder and a TV camera with integration of the visual, laser and TV channels into a single output path to ensure the required parallelism

(b) night optical head with an integrated low-light level TV camera. The lineof-sight can be servo-stabilised to enable sight operations to be conducted on the move

(c) power servo system for the turret and weapons. This consists of an axial pump and hydraulic motor with an asychronous motor as the prime mover. The unit also contains the first stage on the reduction gearing and, on its upper part, the fire control computer and operations panel.

-10° to +85°

SPECIFICATIONS Daylight optical head

ELEVATION RANGE

AZIMUTH RANGE

TELESCOPE

MAGNIFICATION

TELESCOPE

FIELD-OF-VIEW 120

Night optical head

459

 $\times 5$

ELEVATION RANGE AZIMUTH RANGE

-10 to +75° 45°

FIELD-OF-VIEW

4.76

Status: Production. In service with Italian Army and other unspecified

Manufacturer: Officine Galileo SpA, Via Einstein 35, I-50013 Campi

Bisenzio, Florence, Italy.

Telephone: (55) 89501 Telex: 570126 Fax: (55) 8950603



The OTO Melara SIDAM 25 SPAAG is fitted with the Midas sighting and drive

NETHERLANDS

Oldelft TILAS Tank Laser Sight

Development/Description

The Tank Integrated Laser Sight (TILAS) is a modular system incorporating an armoured servo-controlled head mirror and a Nd-YAG 1.064 µm wavelength laser rangefinder, day sight, thermal day/night sight (interchangeable with a second-generation image intensifier night sight), gunner's thermal display and control unit and muzzle reference capability.

Mounted through the roof of AIFVs and MBTs the system's armoured head mirror can be provided with gyrostabilisation for shoot-on-the-move capability. Apart from the gunner's station the TILAS system provides the commander's position with a remote thermal display and control unit with override facilities.

about 8000 m

SPECIFICATIONS

Unit

Laser rangefinder

OPERATING RANGE 200 to 9900 m

RESOLUTION 10 m Thermal sight

FIELD-OF-VIEW 3.6° × 1.4° narrow 10.8° × 4.2° wide

RANGE (tank sized target) Image intensifier sight

MAGNIFICATION $\times 5.6$

Day sight

FIELD-OF-VIEW 6.60

MAGNIFICATION

 \times 8 and \times 3 FIELD-OF-VIEW 7° and 18°

Status: Production. In service with unspecified countries.

Manufacturer: Oldelft, PO Box 72, NL-2600 MD Delft, Netherlands. Telephone: (15) 60 19 01 Telex: 38 345 Fax: (15) 14 57 62



Oldelft TILAS tank laser sight from gunner's side

Oldelft Type TS7TS Gunner's Passive Aiming Sight

Development/Description

The Type TS7TS passive night vision sight is designed to replace the infrared sight on various types of MBTs. It is used by gunners to locate, identify and engage targets at night without using any artificial illumination.

A second-generation 25 mm 3-stage image intensifier tube is fitted, and a gun-following mirror is used to link the gun and the sight in operation.

SPECIFICATIONS

WEIGHT 35 kg

DIMENSIONS $480 \times 325 \times 420 \text{ mm}$

 MAGNIFICATION
 × 7

 FIELD-OF-VIEW
 5.6°

 DIOPTER RANGE
 -5 to +5

POWER SUPPLY 21-30 V DC vehicle system

Status: Production. In service with unspecified countries.

Manufacturer: Oldelft, PO Box 72, NL-2600 MD Delft, Netherlands. Telephone: (15) 601901 Telex: 38345 Fax: (15) 145762



Oldelft Type TS7TS gunner's passive aiming sight

Oldelft Mk 2 Thermal Observation and Aiming Sight for Infantry Fighting Vehicles

Development

The Oldelft Mk 2 thermal observation and aiming sight has been adopted by the Royal Netherlands Army and is in series production of 730 units for incorporation on the YPR-765 Armoured Infantry Fighting Vehicle. It can also be adapted for use on MBTs.

Description

The normal system comprises a thermal camera with a gunner's display, a commander's display, a day sight, an armoured persicope head mirror, a junction box and, optionally, a laser rangefinder.

As an alternative the thermal camera unit can be replaced by a secondgeneration image intensifier sight unit.

The individual component descriptions are as follows:

- (a) gunner's aiming and observation sight with the armoured periscopic mirror head. This has a day sight, with dual magnification and day vision block, and the 60° detector element, split cycle, cyrogenically cooled, thermal camera unit integrated with the gunner's monocular eyepiece 25.4 mm CRT display. An electrically generated and adjustable reticle is projected into the eyepiece
- (b) control unit for the commander with a 50.8 mm CRT display, bi-ocular eyepiece and override functions
- (c) a combined junction box/power supply unit with the system's on/off power switch and stand-by position for the cryogenic cooler
- (d) an interconnecting cable set
- (e) a cleaning installation for the thermal viewer on the head mirror unit.



Oldelft Mk 2 thermal observation and aiming sight for IFVs commander's display

SPECIFICATIONS

POWER SUPPLY

Day sight with day vision block

SIGHT MAGNIFICATION

VISION BLOCK MAGNIFICATION

Thermal camera unit

CRYOGENIC COOLER

DIMENSIONS (including telescope and eyepiece) FIELD-OF-VIEW WAVELENGTH REGION

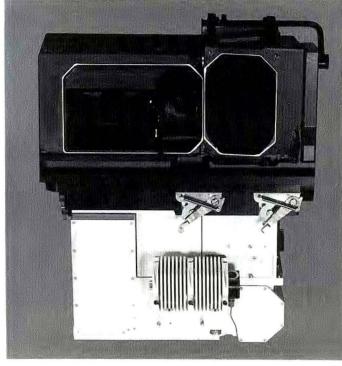
24 V DC

selectable \times 2 or \times 6 \times 1

 $300\times340\times330$ mm selectable $1.7^{\circ}\times4^{\circ}$ and $5.1^{\circ}\times12^{\circ}$ 8-12 μm 0.25 W split cycle

Status: Production. In service with the Royal Netherlands Army (on YPR-765 AIFVs).

Manufacturer: Oldelft, PO Box 72, NL-2600 MD Delft, Netherlands. Telephone: (15) 60 19 01 Telex: 38 345 Fax:(15) 14 57 62



Oldelft Mk 2 thermal observation and aiming sight for IFVs with day sight on left and night sight on right

Oldelft Mk 3 Thermal Observation and Aiming System for MBTs

Development

The Mk 3 thermal observation and aiming system for MBTs was originally developed for the Royal Netherlands Army Leopard 1 MBT update programme and is now being offered for use on other MBT designs as either a retrofit package or a new-build installation item.

Its function is to enable the gunner as well as the vehicle commander to engage and aim at targets at night or in daytime, under conditions of reduced visibility such as haze, light fog, dust and smoke.

The system is intended for use with any laser-fire control system. Interface provisions for that purpose are present in the systems electronics box.

Description

The main subsystems of the Mk 3 are:

- (a) an armoured servo-controlled periscopic head mirror unit incorporating an electronically controlled mirror and an optional muzzle reference system. Gyro signals available in the tank provide the stabilised lineof-sight conditions for circumstances such as shoot-on-the move. If required, an optional independently stabilised mirror unit can be substituted
- (b) a selectable dual field-of-view cryogenically cooled 8-12 μm wavelength region thermal camera which uses a 120 element, parallel scan principle, Mercury Cadmium Telluride (HgCdTe) detector unit and integrated telescope
- (c) a Systems Electronics Box (SEB) which accommodates the control electronics for head mirror unit, the thermal imager, the power supply units for the thermal camera and the displays. An interface for connection to a laser fire control system is also included

- (d) a 101.6 mm Gunner's CRT display tube
- (e) a 50.8 mm Commander's CRT display tube with binocular magnifier. Both this and the commander's display have a NATO standard aiming reticle with a maximum 32-character symbology capability to indicate ammunition type, target distance, system status indications, BITE information and boresight values. Independent brightness controls are available for the symbology and reticle
- (f) a boresighting control unit
- (g) commander's control unit
- (h) gunner's control unit.

SPECIFICATIONS

Head Mirror Unit (gyrostabilised version with panoramic mode option)

ELEVATION RANGE

AZIMUTH RANGE (panoramic option)

PROTECTION (optional)

-20° to +20°

-120° to +120°

10 mm armour steel

Camera with Telescope and Cryogenic Cooler

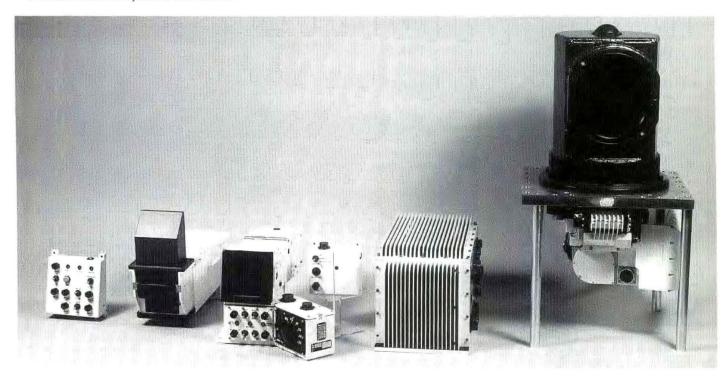
FIELDS-OF-VIEW selectable 3° × 5° and 9° × 15°

WAVELENGTH REGION 8-12 μm

CRYOGENIC COOLER 0.25W split cycle Sterling type

Status: Ready for production.

Manufacturer: Oldelft, PO Box 72, NL-2600 MD Delft, Netherlands. Telephone: (15) 60 19 01 Telex: 38 345 Fax: (15) 14 57 62



Main components of Oldelft Mk 3 Thermal Observation and Aiming System for MBTs, from left to right, commander's control panel, commander's display with integrated direct view prism, gunner's control panel with display above, gunner's boresighting panel (on pedestal), system electronics box, mirror head unit with thermal camera below

Oldelft Low Light Level Television System Type GS6TV

Development/Description

The GS6TV combined night sight and LLLTV camera system is designed for a number of applications including a use on MBTs or armoured fighting vehicles for aiming and/or observation.

For the latter a STANAG-2324 mounting adaptor is used for locating the system on the gunshield. Its low weight precludes the need to rebalance the gun and, as the sight/camera can be fixed close to its axis, parallax is minimised. An armoured cover can be supplied as an optional extra.

The system components comprise an image intensifier sight integrated with a solid-state TV camera, an optional TV-monitor, a control box and interconnecting cable set.

The GS6TV provides the operator with a monochrome monitor image which includes a ballistic reticle. Reticle brightness and image focussing is set via use of the control box.



Oldelft low light level TV system Type GS6TV which is mounted exernally on AFVs

WEIGHTS sight and camera

(without mounting) control box TV-monitor DIMENSIONS

approximately 3.5 kg approximately 1.0 kg customer dependent

440 mm nominal

180 mm nominal

5.9

4.4

Sight and camera

LENGTH DIAMETER FIELD-OF-VIEW

horizontal vertical

Note: 3.7° horizontal × 2.8° vertical is optional to give better resolution

RESOLUTION

TV MONITOR (optional)

POWER SUPPLY

SENSOR

better than 1 mrad at 2 mlux and 85% contrast TUBE second-generation image

intensifier

CCD, 576 V × 604 H pixels, integrated with tube video input, brightness and

contrast controls

24 V DC

Status: Production. In service with unspecified countries.

Manufacturer: Oldelft, PO Box 72, NL-2600 MD Delft, Netherlands. Telephone: (15) 60 19 01 Telex: 38 345 Fax: (15) 14 57 62

SIGNAAL Usfa UA 9124/9126 Day/Night Periscope Sight System

Development/Description

The UA 9124/9126 periscope system is designed for use in armoured fighting vehicles equipped with medium calibre guns or in MBT's.

The modular system is used for day and night observation and gunaiming with its self-contained construction permitting the independent operational use of the UA 1301 day and UA 1124 night periscope vision modules

A vision block of unit-magnification is also incorporated into the design. The entry optics of both the periscopes are coupled to the aiming mechanism of the main gun providing for the elevation of the line-of-sight in collimation with the gun. The vision block provides the gunner with a continuous and steady forward line-of-sight observation capability that is independent of the gun elevation.

The UA 1124 module has a second-generation image intensifier tube fitted with automatic brightness control and point highlight suppression, a built-in and adjustable sky screen, an adjustable elevation/azimuth reticle for ground targets and an adjustable iris-diaphragm.

The UA 1301 module has switchable magnification from \times 2 to \times 6, a built-in and switchable filter for excessive brightness and adjustable elevation/ azimuth reticle for both ground and air targets.

The ground target reticles of the modules are of adjustable intensity. If required, a laser rangefinder can also be incorporated into the system layout.

SPECIFICATIONS

UA 1301 day vision module

FIELD-OF-VIEW

× 2 magnification 510 mils × 6 magnification 170 mils DIOPTER RANGE -3 to +3-10 to +60° FLEVATION RANGE

UA 1301 night vision module

FIELD-OF-VIEW × 6 magnification DIOPTER RANGE -3 to +3**ELEVATION RANGE** -10 to +10°

Vision block MAGNIFICATION

 $\times 1$ FIELD-OF-VIEW horizontal 750

vertical

POWER SUPPLY 20-30 V DC vehicle system



SIGNAAL Usfa UA 9124/9126 Day/Night Periscope Sight Systems

Status: Production. The UA 9126 is in service with the Dutch Army (AIFV YPR 765/806 family) and Belgian Army (M113 APC and variants). It is also used by several NATO countries in coastal artillery applications

Manufacturer: SIGNAAL Usfa, Meerenakkerweg 1, NL-5600 HA Eindhoven, Netherlands

Telphone: +31 40 503 603 Fax: +31 40 503 777

SIGNAAL Usfa UP1011 AND UP1001 Day/Night Aiming and Observation Systems

Development/Description

The UP1011 and UP1001 day/night aiming and observation sights are designed for use on a wide range of armoured fighting vehicles.

The UP1011 is a modular aiming and observation periscope system employing self-contained daylight and image intensifying modules that can be operated independently. The daylight channel has magnification factors of \times 2 and \times 6 and a recognition range of 3000 m in the narrow field-of-view. An eyepiece diopter adjustment is incorporated in each channel.

The UP1001 employs the same modular principles in a thermal imaging/ daylight system to provide full aiming and observation facilities which are entirely independent of the available light conditions.

Operating in the 3-5 µm waveband window, the thermal imager can penetrate through smoke, dust and haze and can provide long-range 'hotspot' detection capabilities. It has × 4 magnification and produces a CCIR video output for use with standard video equipment.

As with the UP1011 assembly, both day and night modules have eyepiece diopter settings and aiming mark adjustments for azimuth and elevation. The system includes a facility for additional display stations inside the vehicle, remote monitoring and record/playback for training and exercise purposes can also be accommodated.

Except for the mirror head and thermal imager or image intensifier modules, the UP1001 and UP1011 systems are identical. This allows economical spares holdings and simplified logistics, together with the ability to upgrade the image intensifier systems to full thermal imaging capability when required.

Each system features a ballistic compensator and either can be supplied with a laser rangefinder incorporated into the daylight sight to provide the operator with accurate range to target information.

SPECIFICATIONS UP1011 Day/Night System

image intensifier daylight channel channel MAGNIFICATION × 6 narrow FOV × 6 × 2 wide FOV FIELD-OF-VIEW 110 mil 170 mil narrow wide n/app 510 mil RANGE observation 800 m n/app 3000 m recognition (narrow) 600 m recognition (wide) n/app 1000 m FOCUSSING DISTANCE 25 m to infinity **EYEPIECE** type monocular setting -3 to +3 diopters

UP1001 Thermal/Daylight System

	tiloilliai ollaillioi	adjugit ondini
MAGNIFICATION		
narrow field-of-view	× 4	× 6
wide field-of-view	× 2	× 2
FIELD-OF-VIEW		
narrow	52 × 33 mil	170 mil
wide	104 × 66 mil	510 mil
RANGE		
recognition (narrow)	1300 m (typical)	3000 m
recognition (wide)	1000 m (typical)	1000 m
detection (wide)	3500 m	n/app
FOCUSSING DISTANCE	50 m to infinity	25 m to infinity
EYEPIECE	and the second second second	William St. Company of Control of
type	monocular	
setting	-3 to +3 diopters	
COOLING	solid state	n/app
AIMING MARK ADJUSTMENT	-5 to +5 mil	- (: 1)

thermal channel

daylight channel

Status: Production.

Manufacturer: SIGNAAL Usfa, Meerenakkerweg 1, 5600 HA, Eindhoven, Netherlands.

Telephone: +31 40 72 26 00 Telex: 51732 usfae nl Fax: +31 40 72 30 40



SIGNAAL Usfa UP1011 and UP1001 Day/Night Aiming and Observation Systems

SINGAPORE

Chartered Industries of Singapore Advanced Compact Thermal Imaging System (ACTIS)

Development/Description

The ACTIS is a joint development between Chartered Industries of Singapore (CIS) and Bendex Avelex Inc of Canada. Developed over a two year period, it was first shown at the Asian Aerospace '92 show.

It uses a miniature state-of-the-art closed cycle cooler to produce a compact hand-held thermal imaging system. The hand-held version has also been adapted as a form of fire control system (when integrated with a laser rangefinder and goniometer) for crew served weapons, such as heavy machine guns and recoilless rifles, so they can engage targets at night.

When mounted on armoured fighting vehicles, for example, the AMX-13SM1 turret mantle, the ACTIS improves the crew's combat effectiveness during night engagements by allowing both passive surveillance and target acquisition. The sight picture is transferred inside to allow the crew to view the imagery whilst under armour.

ACTIS can also be used as a passive tracking system for air defence weapons when it is used in conjunction with a fire control tracker such as a Super Fledemaus. In all applications the reticle pattern is supplied according to the customer requirements.

SPECIFICATIONS

WEIGHT less than 4.6 kg
DIMENSIONS (without

eyepiece) $247 \times 190 \times 135 \text{ mm}$ FIELD-OF-VIEW

narrow 3.5° wide 7°

WAVEBAND REGION DETECTOR TYPE SCANNER TYPE COOLER TYPE DISPLAY TYPE OBJECTIVE FOCUS DIOPTER RANGE RETICLE PATTERN CONTROLS 8-12 μm HgCdTe serial scan closed cycle integral CRT 30 m to infinity -4 to +4 customised

off/standby/on/zoom – a multiple-position switch that controls the electrical power to the system and allows the observer to activate the electronic zooming polarity – black hot/white hot focus – for viewed image reticle – to adjust reticle brightness external power (of 18 w) or 4 × Type C

lithium cells

Status: Production.

POWER SUPPLY

Manufacturers: Jointly developed by Chartered Industries of Singapore and Bendex Avelex of Canada.

Enquiries to: Chartered Industries of Singapore, Unicorn International, 3 Lim Teck Kim Road, No 11-01/02, Singapore Technical Building, Singapore 0208, Republic of Singapore.

Telephone: (65) 2254788 Telex: RS39882 UIPL Fax: (65) 2248862

SLOVENIA

Iskra SG-55 A Tank Commander's Gyrostabilised Sight

Development/Description

The SG-55 gyrostabilised sight is an electro-optical unit designed for the further improvement of T-series MBT sighting systems.

The basic SG-55-A system comprises a gyrostabilised head, a pair of operating handles mounted on the laser rangefinder, an acquisition module, an interconnection box and the various connecting cables.

Installation is by removing the existing protective glass of the commander's periscopic sight, fitting an adapter and then the gyrostabilised head as the external system and the laser rangefinder (TLMD-3S) as the internal system.

In operation, stabilised mirrors are used to observe the battlefield whilst the tank is on the move. This enables the commander to observe the tactical situation, detect and acquire stationary or moving targets and measure their range at distances up to 3000 m. He can, by activating the acquisition mode, automatically position the turret in the direction of the

504 DAY AND NIGHT SIGHTING SYSTEMS / Slovenia — South Africa

chosen target and then align it more precisely by switching to the turret mode, whereby the cupola is locked to the turret and the whole assembly is rotated by means of the azimuth control on the right-hand handle of the laser rangefinder system.

The field-of-view is $\pm 10^\circ$ in azimuth and -15 to $\pm 20^\circ$ in elevation in relation to the cupola.

SPECIFICATIONS

FIELD-OF-VIEW

azimuth ±10° elevation +20/-15° POWER SUPPLY 24 V DC vehicle

Status: In production.

Manufacturer: Iskra Elektrooptika Ljubljana D.D., Stegne 7, PO Box 59,

51 61210 Ljubljana-S entvid, Slovenia.

Telephone: (61) 191 215 Telex: 3951851 yu iskceo



Iskra SG-55-A tank commander's gyrostabilised sight from front showing head and wiper blade

SOUTH AFRICA

Eloptro Integrated Day/Night Gunner's Sighting System GS-21S

Development/Description

The GS-21S is a modular primary gunner's sight for use in MBTs and armoured fighting vehicles. It comprises four major sub-systems:

- (a) GS-21 Sight Housing which contains an entrance window, a mirror attached to an elevation drive mechanism, a day observation channel and a night observation channel, all of which are housed in a rugged light alloy casting. The top mirror is slaved to the vehicle's main armament
- (b) SM-20 Sight Mount which serves as the main mount on the vehicle into which the GS-21 Sight Housing is clipped. The Sight Mount is fitted with two brow pads as a safety feature for use whilst the vehicle is in motion. The cant angle of the SM-20 is adjusted via a cam
- (c) LE-21 Daysight and Laser Elbow this mounts in the GS-21. The diopter setting of the eyepiece is adjustable as is the graticule illumination level. The graticule can be customised and is adjustable to enable boresighting. An integrated laser rangefinder is also fitted which can be boresighted with the NE-21 Night Sight Elbow for laser ranging at night
- (d) NE-21 Passive Night Vision Elbow which mounts in the GS-21 and makes use of a second generation image intensifier tube, providing the vehicle with a full night fighting capability. Graticule illumination is adjustable and ballistic scales can be customised.

Optional sub-systems include the:

- (a) AH-20 Armour Hood which protects the sight housing and is controlled mechanically from inside the turret
- (b) TE-20 Clip-on TV camera which is clipped on the LE-20 to allow the gunner's field-of-view to be displayed on a TV by the instructor and/or vehicle commander for training purposes
- (c) EG-20 Gunner's Episcope night elbow of the GS-21 may be replaced by the EG-20 to give a wider field-of-view during daylight.



WEIGHT **DIMENSIONS**

GS-21 Sight Housing

ELEVATION RANGE ELEVATION ACCURACY SM-20 Sight Mount

YAW ANGLE

CANT ANGLE LE-21 Daysight and Laser Elbow

MAGNIFICATION FIELD-OF-VIEW

MAX RANGE ADJUSTABLE MIN RANGE

GATE ACCURACY RESOLUTION 48 kg

370 × 630 × 420 mm

-18 to +22° 0.2 mil

max 0.7 mils

min ±2 mils, adjustable

× 8

9995 m

300-9990 m

+5

two targets separated by at least 50 m indicated by multiple target

indication

BORESIGHTING RANGE

azimuth -5 to +5 mils -5 to +5 mils elevation POWER-SUPPLY 20-30 V DC

NE-21 Passive Night Sighting Elbow MAGNIFICATION FIELD-OF-VIEW 7.20

FOCUS ADJUSTMENT 60 m to infinity

PERFORMANCE 1.18 lp/mrad at 10⁻¹ lux for a target contrast of 48%

20-30 V DC, autoswitching to dry cell C type or NiCad batteries, 3 V DC

BORESIGHTING RANGE

POWER SUPPLY

azimuth -4 to +4 mils elevation -4 to +4 mils

Status: Production as required. In service with the South African Army.

Manufacturer: Eloptro (Pty) Ltd.

Enquiries to: Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635

Eloptro TV Camera Adaptor TE-20

Development/Description

The TE-20 clip-on TV camera adaptor can be customised to fit the eyepiece of almost any existing MBT or armoured fighting vehicle gunner's sight, for example, the Eloptro GS-21S (qv).

The TV camera adaptor is an optional system which creates an image on a CCD camera. This provides the commander and/or instructor with the scene viewed by the gunner through his sight and is displayed on a TV

The commander and/or instructor sees the gunner's performance during training or in a real exercise and can record it on video tape for later debriefing or assessment.

SPECIFICATIONS

WEIGHT DIMENSIONS 0.6 kg 180 × 55 × 50 mm

CABLE VIDEO **POWER SUPPLY**

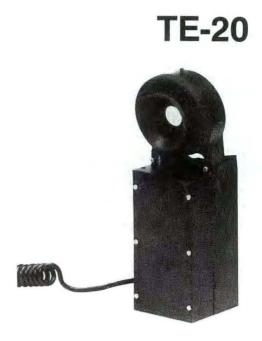
to suit end user CCIR standard

24 V DC

Status: Production as required. In service with the South African Army.

Manufacturer: Eloptro (Pty) Ltd.

Enquiries to: Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635



Eloptro TC camera adaptor TE-20

Eloptro Eland Night Sight Adaptor Type NA-10

Development/Description

The night sight adaptor type NA-10 was developed by Eloptro to provide a night fighting capability for the Eland (4 × 4) 90 mm weapon turret. The NA-10 is equally suitable for use on the 90 mm versions of the Ratel (6×6) IFV as well as the French AML (4 × 4) 90 mm armoured vehicles.

It is a second-generation sight which fits on to the outside of the vehicle turret and in front of the M494 day telescope. The unit magnification afocal design allows for attachment without the need for accurate alignment. The M494 aiming marks are also used for both day and night conditions without any change to the normal fighting drill.

For day time operations the M494 sight looks through the adaptor, while at night the intensified image is reflected into the M494 sight. Focussing and day/night channel selection is controlled from within the turret by means of a control box

The system operates from either the 24 V DC vehicle supply or from internal batteries providing 3 V DC.

Status: Production as required. In service with the South African Army on Eland 90 light armoured cars.

Manufacturer: Eloptro (Pty) Ltd.

Enquiries to: Armscor, Private Bag X337, Pretoria 0001, South Africa. Telex: 320217 Fax: (012) 428 5635 Telephone: (012) 428 1911



AML/Eland second-generation Night Sight Adaptor NA-10

Eloptro Night Vision Adaptor NA-20

Development/Description

The NA-20 is a cost-effective upgrade package for medium calibre direct firing guns such as the 106 mm recoilless rifle.

The system provides day/night firing and target ranging facilities by the fitting of a night vision adaptor and laser rangefinder in front of the existing day sight by means of a customised mounting bracket.

In the case of the 106 mm recoilless rifle the 12.7 mm ranging rifle can either be eliminated from the system or retained in a subcalibre role for training. The effective range of the weapon is also increased from 1200 m to 2000 m in both the day and night roles.

Once fitted, alignment of the NA-20 is easily accomplished without the further need for regular realignment. The only modification to the existing firing drill is the selection of day or night operation by means of a selector switch on the control box and target ranging by means of the hand-held laser rangefinder.

The laser rangefinder can also be removed and used by the gun commander for tasks such as:

(a) ranging to prominent landmarks to verify grid references

(b) laying out firing arcs and ranges for self-protection and emergency use



Eloptro night vision adaptor NA-20 fitted to 106 mm recoilless rifle

- (c) reporting of grid references of activities on the front for intelligence purposes
- (d) assisting artillery, mortar and air strikes by acting as a forward observer. After use the hand-held laser rangefinder can be replaced on the NA-20 mounting bracket without the need for realignment.

SPECIFICATIONS Day/night adaptor

DIMENSIONS 304 × 115 × 285 mm

POWER SUPPLY 20-30 V DC autoswitching to Type B dry cell or 3 V DC NiCad batteries

MAGNIFICATION

 $\begin{array}{ll} \text{night} & \times \, 1 \\ \text{day/night in tandem} & \times \, 4 \end{array}$

FIÉLD-OF-VIEW
night 9.2°
day 10.7°
FOCUS RANGE 20 m to infinity

NIGHT VISION
PERFORMANCE (metres)

1 m target 48% contrast

starlight 120 230 moonlight 220 440

Laser rangefinder (hand-held)

TYPE Nd-YAG

DIMENSIONS 125 × 160 × 70 mm

 WEIGHT
 1.5 kg

 MAGNIFICATION
 × 6

 FIELD-OF-VIEW
 6°

 DIOPTER RANGE
 −4 to +2

OPERATING RANGE 200-8000 m
RANGE GATE 200-3200 m continuous
POWER SUPPLY 12 V NiCad battery

Status. In production. In service with South African Army.

Manufacturer: Eloptro (Pty) Ltd.

Enquiries to: Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635

Eloptro Night Elbow Type NE-20

Development/Description

The NE-20 is a second generation night aiming device designed to be fitted to existing MBT and armoured fighting vehicle gunner's periscopes.

The elevation mirror assembly can either be a stabilised or slaved system. An illuminating project graticule is provided, with boresighting facilities for both elevation and azimuth correction. The graticule illumination is adjustable and the ballistic scales can be customised. The setting of the graticule may be either automatic or manual. A gain control for the image intensifier is also provided.

The night elbow may be used in conjunction with a laser elbow, complementing the night sighting capability with laser ranging. The NE-20 may be either manual or integrated with a Fire Control System.

The NE-20 operates from a 20-30 V DC vehicle supply, with autoswitching

The NE-20 operates from a 20-30 V DC vehicle supply, with autoswitching to either two standard type C dry cell batteries or NiCad batteries. A yellow LED indicates the power source.

SPECIFICATIONS

10 kg WEIGHT DIMENSIONS 350 × 210 × 400 mm MAGNIFICATION $\times 7.12$ FIELD-OF-VIEW GRATICULE AND BALLISTIC SCALES customised FOCUS ADJUSTMENT 60 m to infinity **OBJECTIVE FOCAL LENGTH** 159.6 mm **F NUMBER** 1.6 DIOPTER RANGE -2 to +4

PERFORMANCE 1.18 lp/mrad at 10⁻¹ lux for target

contrast of 48%

POWER SUPPLY 20-30 V DC, autoswitching to dry cell C type or NiCad batteries, 3 V

DC

Status: Production as required. In service with the South African Army.



Eloptro night elbow type NE-20 from the operator's side

Manufacturer: Eloptro (Pty) Ltd.

Enquiries to: Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635

Eloptro Laser Elbow Type LE-20

Development/Description

The LE-20 laser elbow is an integrated daylight and laser rangefinder elbow that can be fitted to a number of existing tank gunner periscope types. It may also be integrated with a night elbow so offering the gunner full night sighting capabilities in laying the main armament, either manually or with the assistance of an integrated fire control system.

Features of the system include:

- (a) fire control system data displayed in the eyepiece ('ready-to-fire')
- (b) self-test with on-switch indication
- (c) multiple laser return indication
- (d) master failure indication

SPECIFICATIONS

DIMENSIONS 340 × 100 × 380 mm

WEIGHT 7 kg

POWER SUPPLY 20-30 V DC MAGNIFICATION $\times 8$ FIELD-OF-VIEW 80 DIOPTER RANGE -4 to +2

FOCUS fixed at infinity, optimised at 1200 m **DUAL GRATICULE** fixed graticule with laser aiming mark and

ammunition ballistic scale, moving graticule with NATO cross

Laser rangefinder MAX RANGE DISPLAYED 9995 m

RANGE LOGIC 1st and 2nd target RANGE GATE 300 to 9990 m

PULSE REPETITION 1 pulse per 6 s or 3 pulse per 5 s at 13 s

intervals

EYEPIECE DISPLAY self test with switch-on indication

master failure indication

range readout

provision for two displays for fire control

system

multiple return indication interfacing (such as 'ready-to-fire')

Status: Production as required. In service with undisclosed countries.



Eloptro Laser Elbow Type LE-20

Manufacturer: Eloptro (Pty) Ltd.

Enquiries to: Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635

TS-30

Eloptro Thermal Elbow TS-30

Development/Description

The TS-30 all-weather day and night observation and targeting modular thermal imaging system is specifically intended for use with GS40 and GS50 gunner's sights as used in South African Army MBTs and armoured fighting vehicles. The system comprises a sensor unit, associated electronics, video display and control units, all of which are linked by an interconnecting

The system can be electrically interfaced to a fire control system computer and has an integrated boresightable NATO reticle. Automatic or manual adjustment of the gun and level can be made. Two separately buffered video outputs are available whilst system testing is catered for by comprehensive Built-in Test facilities.

SPECIFICATIONS

WAVERAND 8-12 µm DETECTOR TYPE CMT NUMBER OF DETECTORS 120

COOLING closed cycle split-Sterling FIELD-OF-VIEW

 $4.71 \times 3.26^{\circ}$ original

from 1st quarter 1993 $3.3 \times 2.3^{\circ}$ and $8 \times 5.5^{\circ}$

OBJECTIVE DIAMETER 75 mm SCAN RATE 25 Hz

0.1°C for 1 Cy/mrad MRT

DISPLAY CCIR Video COMMUNICATION INTERTACE RS422 POWER SUPPLY 28 V DC BORESIGHT RETENTION ±0.2 mrad

Status: Production as required. In service with the South African Army.

Manufacturer: Eloptro (Pty) Ltd.

Enquiries to: Armscor, Private Bag X337, Pretoria 0001, South Africa. Telephone: (012) 428 1911 Telex: 320217 Fax: (012) 428 5635

Thermal Elbow

Eloptro thermal elbow TS-30

SPAIN

ENOSA PP-01 Aiming Periscope

Development

The PP-01 aiming periscope was designed for use with the CETME TC-3 family of turrets mounted on armoured fighting vehicles such as the M113 APC and the BMR-600 IFV.

Description

The periscope consists of two main parts:

(a) the upper or swivel-mounted prism head assembly

(b) the lower or sight body assembly.

These are joined by a mounting stand unit with a graduated gunsight drive that synchronises the transmission of elevation angles to the prism head.

In the sights an adjustable intensity cross-hair reticle facilitates the aiming procedure. The ammunition reserve status is indicated by a luminous warning which appears above the cross-hairs.

SPECIFICATIONS

WEIGHT 12.4 kg

 $\begin{array}{lll} \text{DIMENSIONS} & 360\times240\times180 \text{ mm} \\ \text{ELEVATION} & -20^{\circ} \text{ to } +70^{\circ} \\ \text{AZIMUTH} & \pm45 \text{ mils} \\ \text{PERISCOPE HEIGHT} & 265.5 \text{ mm} \\ \text{MAGNIFICATION} & \times 1 \end{array}$

FIELD-OF-VIEW
horizontal 43°
vertical 11°
POWER SUPPLY 24 V DC

Status: Production. In service with the Spanish armed forces and other unspecified countries.

Manufacturer: Empresa Nacional de Optica SA (ENOSA), Polígono Industrial 'La Mina' (P 11), E-28770 Colmenar Viejo (Madrid), Spain.

Telephone: (91) 846 0100 Fax:(91) 846 0102



ENOSA PP-01 observation and aiming periscope

ENOSA PP-02 Observation and Aiming Periscope

Development

The PP-02 observation and aiming periscope has been developed for use on the BMR-600 IFV turret but can be adapted for use on other types of turrets or machine gun mounts if required.

Description

It consists of three main parts:

- a) the top or tilting prism head which is connected to a graduated drive unit to synchronise the transmission of the elevation angles
 - b) a binocular observation sight unit
- a dual magnification monocular telescope which has an adjustable intensity reticle projected into its eyepiece, suitable for use against both air and land targets.

All three are joined together on a mounting support.

SPECIFICATIONS

WEIGHT 27 kg

DIMENSIONS $460 \times 340 \times 320 \text{ mm}$

ELEVATION -20° to +70°

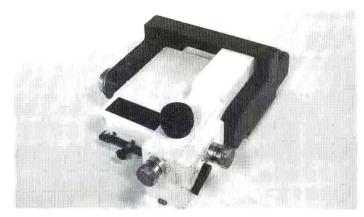
PERISCOPE HEIGHT

over mounting 300 mm POWER SUPPLY 24 V DC

Binocular sight

MAGNIFICATION × 1
FIELD-OF-VIEW

horizontal 43° vertical 11°



ENOSA PP-02 observation and aiming periscope

Telescope

FIELD-OF-VIEW

× 2.6 magnification 28° × 6.7 magnification 9° DIOPTER RANGE –5 to +2

Status: Production as required. In service with the Spanish armed forces.

Manufacturer: Empresa Nacional de Optica SA (ENOSA), Polígono Industrial 'La Mina' (P 11), E-28770 Colmenar Viejo (Madrid), Spain.

Telephone: (91) 846 0100 Fax: (91) 846 0102

ENOSA PP-03 Aiming Periscope

Development

The PP-03 aiming telescope is designed to be fitted to AFV turrets equipped with light automatic cannon or machine guns.

Description

It consists of two main parts:

a) the tilting top body or prism head

b) a lower body with a bi-ocular observation sight and a monocular aiming periscope. The latter has an adjustable illumination stadiametric reticle with lines or strokes for engaging moving targets. The observation system also has an open sight alidade that acts as a reference for centring the aiming periscope.

As an option for night operations the whole of the lower body can be replaced by a CP-25 passive night vision elbow. Both the parts are joined by a mounting support.

WEIGHT 13 kg

DIMENSIONS 230 × 190 × 375 mm –20° to +70° **ELEVATION** 24 V DC **POWER SUPPLY**

Bi-ocular sight MAGNIFICATION FIELD-OF-VIEW horizontal vertical

Aiming telescope

MAGNIFICATION $\times 3$ FIELD-OF-VIEW 12° DIOPTER SETTING -0.75

Status: Production as required. In service with unidentified countries.

Manufacturer: Empresa Nacional de Optica SA (ENOSA), Polígono Industrial 'La Mina' (P 11), E-28770 Colmenar Viejo (Madrid), Spain.

Telephone: (91) 846 0100 Fax: (91) 846 0102

ENOSA AMX-30E MBT Commander's and Gunner's Optical Equipment

Development/Description

As part of the Spanish AMX-30E production programme ENOSA was licensed to build the optical equipment from various French manufacturers. The systems built include the following:

M-268 NBC Protected Tank Commander's Periscope **SPECIFICATIONS** 10.8 kg

 $\times 1$

WEIGHT PERISCOPE HEIGHT

165 mm CLAMPING HOLE

MEASUREMENTS 250/190 × 100 mm

MAGNIFICATION FIELD-OF-VIEW

horizontal 2200 mils vertical 800 mils

M-270 Tank Commander's Prism Head

The M-267 daylight and the OB-23A infra-red night vision binocular elbow aiming telescopes are fitted to this as the armoured semi-periscopic

Externally mounted on a balanced platform attached to the head are the machine gun carriage and the PH-9A clear and infra-red light projector unit.

SPECIFICATIONS

-8° to +40° **ELEVATION AZIMUTH** ±6 mils

M-267 Tank Commander's Binocular Daylight Elbow Aiming Telescope

This is attached to the M-270 prism head and is used by the tank commander for daylight observation and machine gun aiming. A reticle is provided which is illuminated by a 1.5 V cadmium-nickel dry cell battery.

MAGNIFICATION $\times 10$ 100 mils FIELD-OF-VIEW

OB-23A Tank Commander's Binocular Infra-red Night Vision Elbow Aiming Telescope

This is fitted to the M-270 prism head and is used by the tank commander for night-time observation and machine gun aiming. Power is provided by a 1.5 V dry cell battery.

SPECIFICATIONS

MAGNIFICATION $\times 4.1$ FIELD-OF-VIEW 90

M-282 Gunner's and Loader's Orientation Observation Periscopes

On the gunner's station the M-282 may be replaced by the OB-17A infra-red night vision aiming periscope.

SPECIFICATIONS

WEIGHT 6.1 kg CLAMPING HOLE

MEASUREMENTS 116 × 56 mm PERISCOPE HEIGHT 330 mm

FIELD-OF-VIEW 750 mils horizontal

vertical 460 mils

OB-17A Gunner's Monocular Night Aiming Infra-red Periscope

This functionally takes over the role of the M-271 daylight aiming periscope during night-time engagements and physically replaces the gunner's M-282 orientation observation periscope. A variable illumination reticle is projected into the eyepiece with the power being supplied by a 1.5 V dry cell battery. Infra-red illumination is provided by the main PH-8A clear and infrared light projector.

SPECIFICATIONS

MAGNIFICATION × 5.4 **ELEVATION** -8° to +20° FIELD-OF-VIEW

M-271 Gunner's Monocular Aiming Telescope Sight

This is an articulated sight assembly with cross-hair mobility and scales on the reticle for the various types of 105 mm main gun ammunition used. It is also fitted with a Wollaston system for target straightening or levelling.

Mounting on the gun is done via the M-275 cross head on which height and direction error corrections can be carried out with an amplitude of 15 mils.

SPECIFICATIONS

MAGNIFICATION × 8 FIELD-OF-VIEW

Status: Production as required. All the above sights are in service with the Spanish Army (on AMX-30E MBTs).

Note: The M-208 tank commander's coincident rangefinder telescope is the only optical equipment for the AMX-30E not produced by ENOSA and was bought in from its French producer.

Manufacturer: Empresa Nacional de Optica SA (ENOSA), Polígono Industrial 'La Mina' (P 11), E-28770 Colmenar Viejo (Madrid), Spain.

Telephone: (91) 846 0100 Fax: (91) 846 0102

SWEDEN

NobelTech Electronics AB Type FV Day/Night Gunner's Sight

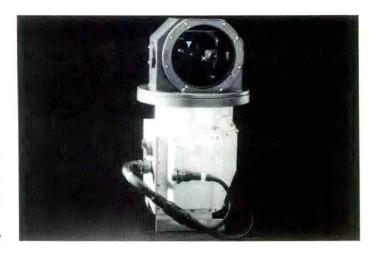
Development/Description

The Type FV gunner's day/night sight is a component of the NobelTech Fire Control System (qv) for armoured fighting vehicles. It is fitted with day and low light level night vision path systems and has a miniature laser rangefinder integrated into the system.

All the optical channels are aligned with their directions in azimuth and elevation controlled by a servo-driven gyrostabilised top mirror to ensure a stabilised line-of-sight.

Tracking is performed independently of the movements of the turret and gun, so that all the gunner has to do is keep the line-of-sight on the target. He can then measure the range by use of the laser, even when the gun has already been re-aligned, by the fire control system on to the target's predicted future position as the sight's line-of-sight counter rotates with the lead angle and superelevation

NobelTech Type FV day/night T-series gunner's sight



510 DAY AND NIGHT SIGHTING SYSTEMS / Sweden - Switzerland

Status: Production. In service with several undisclosed countries (on T-series tanks).

Manufacturer: NobelTech Electronics AB, S-17588 Järfälla, Sweden. Telephone: +46 758 10000 Fax: +46 758 32244

SPECIFICATIONS

FIELDS-OF-VIEW

× 7 magnification day channel × 8.5 magnification night channel 9° 5.3° DIOPTER RANGE LASER RANGEFINDER

wavelength operating range

-5 to +5

1.064 µm typically 6000 m

Ericsson Gunner's Integrated Tank Laser Sight

Development/Description

The Ericsson integrated tank laser sight was initially developed in the midseventies for a foreign project (first prototype 1978) and then as part of the Swedish Centurion MBT upgrade programme (first prototype 1982). However, it is available for fitting to other tank types with orders having been received from two countries.

The sight comprises:

(a) an integrated gunner's sight assembly and miniaturised Nd-YAG 1.06 μm laser rangefinder unit. Range performance is 6000 m with an accuracy of ± 10 m

For night fighting purposes a mechanical filter is built into the optics to protect the operator from excessive light when the main gun is fired.

In addition to the normal gun firing capability, there is also a large field-of-view for observation purposes.

The laser rangefinder is designed to interface with the vehicle's fire control computer and for convenience is equipped with a continuous blocking range. Boresighting of the laser to the gun is facilitated by the adjustable inner chassis of the laser sight. The laser trigger button is located on the gunner's control handle

(b) a spot injection unit which presents an aiming mark in the gunner's left side eyepiece of the sight as a red dot superimposed on the target. The aiming mark position is calculated by an interfaced ballistic fire control computer.

SPECIFICATIONS

WEIGHT 11 kg POWER SUPPLY 24 V DC

Sight

MAGNIFICATION × 10 FIELD-OF-VIEW 100 mrad

Observation sight

MAGNIFICATION × 1

FIELD-OF-VIEW 42° azimuth × 14° elevation

LASER TYPE Nd-YAG
WAVELENGTH 1.06 µm

RANGE CAPABILITY 6000 m (against ground target)

ACCURACY ±10 m

Status: Production as required. In service with Denmark (on Centurion MBTs), Sweden (on Centurion MBTs) and India (on Vijayanta MBTs).



Latest version of Ericsson Gunner's Integrated Tank Laser Sight for Swedish Army Centurion upgrade programmes

Manufacturer: Ericsson Radar Electronics AB, Surface Sensors Division, S-43184, Mölndal, Sweden.

Telephone: (31) 671000 Telex: 20905 Fax: (031) 673813

SWITZERLAND

Leica BIG2 Commander's Night Vision Goggles

Development/Description

The BIG2 commander's passive night vision goggles can be used for a wide range of night operations including observation from vehicles. Mounted in a watertight housing the goggles use a single image intensifier tube with binocular eyepieces. When in use they are strapped to the head with an individually adjustable harness.

A variety of 18 mm image intensifier tubes (second-generation, improved second-generation or third-generation) can be fitted. With an eyebase of 57 to 71 mm and a diopter range of –5 to +4.5 the BIG2 can easily be adjusted to the operator's eyes. A built-in infra-red diode provides close illumination for map reading or for operating equipment. A luminous mark near the lower edge of the visual field shows when this facility is operating.

In average conditions a man-sized target can be recognised at a range of more than 200 m.



Leica BIG2 commander's night vision goggles in use

WEIGHT complete goggles

800 g 580 g 220 g

harness DIMENSIONS

goggles MAGNIFICATION RESOLUTION FIELD-OF-VIEW 160 × 140 × 60 mm

× 0.98 0.6 lp/mrad

41°

BATTERY 1 × 2.7 V lithium or 2 × 1.5 V alkaline
FOCUS RANGE 25 cm to infinity
OBJECTIVE 24.9 mm, f/1.3

Status: Production. In service with unspecified countries.

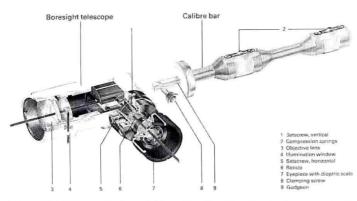
Manufacturer: Leica AG, CH-9435 Heerbrugg, Switzerland. Telephone: (071) 70 31 31 Telex: 881 222 31 wi ch

Fax: (071) 721 865

Leica SZR/SKS Muzzle Boresight

Development

The Wild SZR/SKS series of muzzle boresights are designed for the precision alignment of all standard armament bores from 7.62, 12.7, 20, 25, 30, 40, 75, 90, 100, 105, 120 through to 155 mm calibre and TOW missile launchers. The applications include use on armoured vehicles (for example, tank main and secondary weapons, the cannon on armoured infantry combat vehicles), field guns, howitzers, mortars and anti-aircraft guns.



Leica SZR/SKS muzzle boresight sectionalised to show main components

Description

The light alloy basic unit consists of an angled telescope and one or more interchangeable calibre bars, from the wide range available, to fit the desired bore size(s).

The standard eyepiece of the model SZR2 boresight telescope can be replaced by a GLO-2 laser eyepiece which projects the bore centreline as a visible red dot.

The model SRZ2-1 is the MIL-standard tested version of the boresight telescope. This has a fixed eyepiece and a reticle illumination window for use at night. An external light source is shone through the window. Supplementary front lenses are available for use at 10 m (lens model SVO-1), 25 m (lens model SVO-3) and 40 m (lens model SVO-2).

SPECIFICATIONS

WEIGHT

telescope 0.3 kg DIMENSIONS 111 × 94 × 42 mm

MAGNIFICATION ×6

FIELD-OF-VIEW 85 mils
DIOPTER RANGE -5 to +5

RETICLE cross hairs with 1 mil graduations
CENTRING ACCURACY ±0.1 mil (telescope to calibre bar)

Status: Production. In service with several undisclosed countries (including some in NATO).

Manufacturer: Leica AG, Special Products Division, CH-9435 Heerbrugg, Switzerland.

UNITED KINGDOM

Avimo NV40 Gunner's Passive Night Vision Periscope

Development/Description

The NV40 passive night vision periscope is designed to be a direct replacement for the gunner's TPN-1-41-11 infra-red sight on T-54/55/62 and Type 59 MBTs.

It comprises the following subsystems:

(a) night vision elbow which is a modified version of the standard US Army night vision elbow specifically for use with T-series MBT fire control systems. The improvements include a rechargeable battery, bayonet connector, ballistic graticule and special shorter eyepiece unit. The image intensifier tube is of the second-generation type with muzzle flash protection features.

Typical maximum detection range against a tank sized target in starlight is 1300 m and in moonlight 2700 m $\,$

(b) periscope head assembly which is similar to the original one used with the TPN-1-41-11 sight. All the optics are coated to prevent glare and improve the image contrast

(c) sight mount which is attached to the turret roof and supports the head assembly and passive night vision elbow. The mount also houses the two-bar linkage which controls the head mirror rotation.

SPECIFICATIONS

 WEIGHT
 35 kg

 MAGNIFICATION
 × 7.1

 FIELD-OF-VIEW
 7.3°

Status: Production as required.

Manufacturer: Avimo Limited, Lisieux Way, Taunton, Somerset TA1 2JZ, LIK

Telephone: (0823) 331071 Telex: 46126 Fax: (0823) 274413



Avimo NV40 Gunner's Passive Night Vision Periscope for T-54/55/62 and Type 59 MBTs

Avimo NV46 Commander's Passive Night Vision Periscope

Development/Description

The NV46 passive night vision periscope is designed to be directly interchangeable with the existing commander's infra-red sight of the T-54/55/62 and Type 59 MBTs.

It is mounted into the same position by using the same mounting system as its predecessor. The dual hand grip contains the search light and cupola rotation controls.

The second-generation image intensifier tube fitted can either be of the 18 or 25 mm type with automatic brightness control for protection against muzzle flash and sudden battlefield illumination. A 6000 per 360° mil scale graticule and 2.7 m stadia target height scale are also included. The focus and brightness controls are located on the hand grip.

In the event of primary source vehicle power failure, two GE KOIAIIIC GT3 rechargeable batteries are incorporated in the sight for emergency

SPECIFICATIONS

WEIGHT 5.7 kg

DIMENSIONS 340 × 270 × 240 mm

MAGNIFICATION × 4.4 FIELD-OF-VIEW 11° DIOPTER RANGE –5 to +4

Status: Production as required.

Manufacturer: Avimo Limited, Lisieux Way, Taunton, Somerset TA1 2JZ,

UK.

Telephone: (0823) 331071 Telex: 46126 Fax: (0823) 274413



Avimo NV46 Commander's Passive Night Vision Periscope for T-54/55/62 and Type 59 MBTs

Avimo NV(L) 3001 Day/Night Laser Rangefinder Sight Family

Development

The NV(L) 3001 series is a modular concept family of sights. Their design has resulted in a series of low cost sight assemblies suitable for use in a wide range of light armoured vehicles. Versions have already been procured for use in Scorpion tracked reconnaissance vehicles mounting 76 mm and 90 mm guns and for a MAOV programme.

The design is such that the sight may be used in either the gunner's or the commander's stations. The modular design allows for the fitting of a wide variety of elbows which range from standard daylight types through to a thermal imager model.

Description

The basic system is comprised of four major modules:

- (a) an intermediate body which incorporates the mounting interface and to which are attached all the other system modules. It also provides a unity vision facility, selectable by a flip mirror, in the daylight channel
- (b) a sight head which houses either the head mirror or prism which are common to both the day and night channels. It is the only part of the sight which protrudes above the armour. Ballistic protection is provided by means of a separate armoured cowl
- (c) a self-contained daylight elbow which has either a simple daylight telescope or a daylight facility incorporating a laser rangefinder unit. The laser transmitter is a separate LRU which may be replaced without disturbing the integrity of the sighting unit
- (d) a night vision elbow that can either be the second-generation image intensifier type or a thermal imager. When the latter is fitted certain glass elements in the sight head and intermediate body assemblies are replaced with germanium.

Separate boresight facilities on each elbow allow the night vision elbow



Avimo NL(L) 3001 day/night laser rangefinder sight

to be boresighted to the daylight/laser elbow thus enabling the laser rangefinder unit to be used at night. Further design growth features are incorporated into the system to allow for future technological developments.

Status: Production as required. In service with a number of undisclosed countries.

Manufacturer: Avimo Limited, Lisieux Way, Taunton, Somerset TA1 2JZ, LJK

Telephone: (0823) 331071 Telex: 46126 Fax: (0823) 274413

SPECIFICATIONS WEIGHT	34 kg	RANGE COMPUTATION Image intensifier elbow	first/last pulse logic
DIMENSIONS		MAGNIFICATION	x 7
length	345 mm	FIELD-OF-VIEW	7.3°
width	430 mm (across flanges)	FOCUS	25 m to infinity
height	680 mm (with cowl)	IMAGE INTENSIFIER TUBE	25 mm second-generation
POWER SUPPLY	18 – 32 V DC	RESOLUTION	-
Head assembly		0.1 lux	0.21 mil
MIRROR MOVEMENT	-19° to +35°	0.001 lux	0.36 mil
FIELD-OF-VIEW		BORESIGHT ADJUSTMENT	±7 mils
horizontal	45°	Thermal elbow	
vertical	25°	WAVEBAND REGION	8-12 μm
Laser daylight elbow		MAGNIFICATION	
MAGNIFICATION	x 8	wide	x 8
FIELD-OF-VIEW	8°	narrow	x 4.9
LASER TYPE	Nd-YAG	FIELD-OF-VIEW	
WAVELENGTH	1.064 µm	wide	9.6° x 5.6°
OPERATING RANGE	200-9995 m	narrow	3.9° x 2.3°
ACCURACY	±5 m		

Pilkington Optronics Systems for Challenger

Development/Description

Pilkington Optronics has been awarded a contract worth in excess of £40 million by Vickers Defence Systems to supply sighting, fire control and target acquisition systems for the 127 Challenger 2 MBTs it is building for the British Army over the period 1992-95.

The systems to be provided include:

- (a) a Thermal Observation and Gunnery Sight II (TOGS II)
- (b) a stabilised Gunner's Primary Sight (GPS)
- (c) a Passive Driving Periscope (PDP) which uses image intensified night vision to enable the driver to proceed at night, hatch down and without the use of artificial illumination at speeds comparable to those achievable during daytime.

Status: TOGS II, GPS and PDP in production. On order for the British Army (Challenger 2 MBT).

Manufacturer: Pilkington PE Ltd, Glascoed Road, St Asaph, Clywd LL17 OLL. UK

Telephone: (0745) 588000 Telex: 61430 Fax: (0745) 584959



Thermal Imaging Sensor Head (TISH) for Challenger 2 MBT

Barr and Stroud Thermal Observation and **Gunnery Sight**

Development/Description

The Thermal Observation and Gunnery Sight (TOGS) system started development in 1981 under an MoD contract placed with Barr and Stroud to design a sight for use in the detection, tracking and engagement of battlefield targets by day and night and in adverse weather or battlefield conditions.

It is fitted to the Challenger 1 MBT on the right side of the turret and has been backfitted to at least 324 vehicles of the British Army's Chieftain MBT fleet in place of the infra-red/white searchlight mounted on the left side of the turret.

TOGS can be used either by the tank commander or gunner to produce a thermal picture of the external scene and the necessary information to aim and fire the 120 mm L11 series rifled main armament.

A dual field-of-view telescope provides the target acquisition and vehicle navigation facility in the wide angle, and allows target recognition. identification and gun aiming in the narrow angle. Focus is maintained even when the field-of-view is changed and can be varied as required. If necessary TOGS will also operate with the existing visual sighting system of a retrofitted tank.

The TOGS equipment comprises three separate system groups

- (1) The Built-In Test Equipment (BITE) Group to constantly monitor each line-replaceable unit and give a visual warning of any malfunction found
- (2) Gunnery Sighting System Group which turns what would otherwise be a thermal imager into a gun sighting system. It consists of the following system sub-units:
 - (a) Servo Trunnion Unit which supports the Thermal Imager Sensor Head (TISH), drives it in elevation and maintains its line-of-sight to the target throughout the engagement
 - (b) Servo Electronics Unit which controls and drives the Servo Trunnion Unit
 - (c) Symbology Processing Unit which is effectively the heart of the TOGS system. It controls the TISH servo, generates the video graphic signals, notable aiming marks and BITE messages for the displays by interpreting data inputs including BITE messages from

- the other units, gun elevation and, from the fire control computer, tangent elevation and offset for the engagement
- (d) Coolant Supply Unit which provides high pressure air to the TISH. Reservoir bottles provide a silent watch capability
- (e) Isolating Converter Unit which acts as the main power converter for the TOGS system. A standard vehicle 28 V DC supply is used as the primary power source
- (f) Trunnion Tilt Sensor
- (3) Thermal Surveillance System Group which acts as the eyes of TOGS, detecting and recognising the target and providing both the commander and gunner with visual displays. It comprises the following sub-units:
 - (a) Thermal Image Sensor Head (TISH) which is an environmentally sealed unit mounted within the Servo Trunnion Unit that is located in an armoured barbette on the exterior of the tank turret. It contains an afocal dual field-of-view telescope and scanner assembly

Thermal radiation from the scene in the 8-11.75 µm waveband region is collected by the telescope and focussed onto the scanner's eight element parallel CMT 'Sprite' detector. The 'Sprite' converts this thermal radiation into electrical signals for use in the Thermal Imaging Processing Unit. High pressure air from the Coolant Supply Unit is used to cool the detector. A wash/wipe unit is provided to clear and clean the TISH objective lens

- (b) Thermal Imaging Processing Unit which receives the electrical signals generated by the TISH and converts them to television format electrical signals for presentation to the commander's and gunner's display units. Provision is made within the unit for mixing externally generated graphics such as aiming marks and BITE signals into the TV signal
- (c) Commander's and Gunner's Display Units which present the thermal picture together with graticule, aiming marks and BITE information to the viewer using a standard CCIR 625 line 50 Hz composite video output from the Thermal Imager Processing Unit. If required a 525 line 60 Hz video output can be used instead.

A facility is provided whereby the displays can be activated by the operator pressing the brow switch mounted in the binocular viewer. This mode of operation prevents stray light from the displays disclosing the position of the vehicle at night.



TOGS on Vickers Defence Systems Challenger 1 MBT with doors open



Thermal imaging sensor head used in TOGS

In addition to the three basic System Groups TOGS also has:

- (a) Gunner's and Commander's Display Drive Units which generate the high tension voltage required for the CRT displays and provide the Grey Scale necessary to calibrate the displays for contrast, brilliance and focus
- (b) Gunner's Control Panel which contains all the functions necessary for target acquisition and engagement, including the field-of-view change switch, focus, gain and black level controls and polarity setting (ie black/ white hot) control.

All the controls are duplicated at the Commander's station via the Symbology Processing Unit.

Status: Production. In service with the British Army (on Challenger 1 and retrofitted Chieftain MBTs) and improved version is now in production for the Challenger 2 MBT which has the thermal camera mounted over the 120 mm gun mantlet.

Manufacturer: Barr & Stroud Limited, 1 Linthouse Road, Glasgow G51 4BZ, Scotland, UK.

Telephone: (041) 440 4000 Telex: 778114 GLW G

Fax: (041) 440 4001

Barr and Stroud Tank Laser Sight

Development/Description

The Tank Laser Sight (TLS) was developed from the Chieftain Tank Laser Sight using internal system located mini-module technology to reduce mechanical and electrical problems normally associated with sight installation.

This has resulted in the equipment becoming suitable for a wide range of vehicle types with installations having been made at the gunner's position on Centurion, Leopard 1 and Scorpion armoured vehicles.



Barr and Stroud Tank Laser Sight as installed in Chieftain MBT

The tank laser sight unit houses the Nd-YAG laser transmitter, the receiver system and the optical sight. The line-of-sight in elevation is aligned to the axis of the gun by means of precision parallel linkage and azimuth by coincident turret mounting.

Boresighting is achieved using controls on the sight unit in conjunction with either a muzzle boresight or the muzzle reference system. Gun laying is achieved by using a ballistic graticule or an aiming mark provided by a fire control computer. The latter is obtained by the ability of the sight to accept a conversion kit which provides a graticule aiming mark projection system for integration within a computer-driven fire control system.

If required, the sight can also be used with a thermal imaging system.

Laser ranging can be initiated directly by the gunner or remotely by the vehicle commander. The range is displayed in the left eyepiece of the sight unit and remotely at the commander's station on a range read-out unit.

When a target is partially obscured by smoke or other obstacles the selection of 'last range' on the range unit allows the true range to be obtained by eliminating all received echoes other than the last one, which comes from the target.

SPECIFICATIONS

WEIGHT	
sight unit	21 kg
commander's range	
read-out unit	0.68 kg
electronics unit	7 kg
DIMENSIONS	
sight unit	$333 \times 289 \times 518$ mm
commander's range	
read-out unit	$152 \times 54 \times 60 \text{ mm}$
Sighting telescope	
MAGNIFICATION	× 10
FIELD-OF-VIEW	8.5°
Acquisition sight	
MAGNIFICATION	× 1
Laser rangefinder	
LASER TYPE	Nd-YAG
WAVELENGTH	1.064 µm
OPERATING RANGE	300-10 000 m
ACCURACY	±10 m (90% of shots)

Status: Production as required. The Barr and Stroud Tank Laser Sight is installed in many AFVs including Challenger 1 (United Kingdom), Chieftain, (Iran, Kuwait and United Kingdom), Khalid (Jordan) and Scorpion (Dubai).

Manufacturer: Barr & Stroud Limited, 1 Linthouse Road, Glasgow G51 4BZ, Scotland, UK.

Telephone: (041) 440 4000 Telex: 778114 GLW G Fax: (041) 440 4001

Barr and Stroud IR26 Thermal Imaging Sensor Head (TISH)

Development/Description

The IR26 Thermal Imaging Sensor Head (TISH) is the latest member of the IR18 family. It has been designed and built around the latter's scan head using the four-element cryogenically cooled Sprite detector technology operating in the 8-13 μ m infra-red wavelength region and processing electronics on plug-in PCBs housed in a Thermal Imaging Processing Unit (TIPU). The latter can be located up to 10 m away.

(TIPU). The latter can be located up to 10 m away.

The video output (CCIR System 1 (625 line, 50 Hz) or EIA (525 line, 60 Hz)) is fully compatible with normal European or American TV standards and can, therefore, be fed to any standard TV display or video recorder. It can also be transmitted over a microwave link if required.

The IR26 has been built for external use on any AFV, tracked platform or guided weapon system.



28 V DC

8-13 µm

287 × 295 × 237 mm

installation dependent

The sensor head incorporates a dual field-of-view telescope which is of the type fitted to TOGS (qv) but has a different performance capability. The wide field-of-view is used for surveillance and target detection whilst the narrow field-of-view is suitable for target recognition/identification and fire control purposes.

SPECIFICATIONS

WEIGHT

IR26 TISH unit 19.9 kg TISU 12 kg

control unit

installation dependent

DIMENSIONS

IR26 TISH unit 510 × 284 × 310 mm TISLL control unit POWER SUPPLY WAVEBAND REGION FIELDS-OF-VIEW

horizontal 13.6° and 4.75° vertical 9.1° and 3.18°

Status: Production. In service.

Manufacturer: Barr & Stroud Limited, 1 Linthouse Road, Glasgow G51

4BZ, Scotland, UK,

Telephone: (041) 440 4000 Telex: 778114 GLW G Fax: (041) 440 4001

Barr and Stroud HDTI 2000 Compact Thermal **Imaging System**

Development/Description

The HDTI modular ruggedised thermal imager is based on the Sprite detector and designed for use in a variety of high performance systems including vehicle-mounted thermal imaging systems. The modularity allows the unit to be reconfigured to the customer's space envelope and the inclusion of a closed cycle cooler permits it to be fully self contained.

The system is offered with user defined field(s)-of-view and the telescope fitted can range from passively athermalised single field-of-view to high performance zoom systems. The video output from the sensor is configured to be compatible with either European or US TV formats.

SPECIFICATIONS

WEIGHT FIELD-OF-VIEW

narrow wide 9 × 6°

MIN RESOLVABLE TEMPERATURE

DIFFERENCE (MRTD) VIDEO OUTPUT

POWER SUPPLY

6 kg

3 × 2°

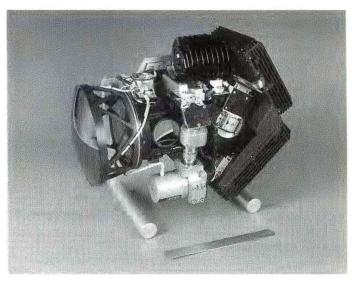
0.21 K at 3 cycles/mrad spatial

frequency

CCIR System I (625 line, 50 Hz) or EIA RS170 (525 line, 60 Hz)

28 V DC

Status: Ready for production.



Barr & Stroud HDTI 2000 compact thermal imaging system

Manufacturer: Barr & Stroud Limited, 1 Linthouse Road, Glasgow G51

4BZ, Scotland, UK.

Telephone: (041) 440 4000 Telex: 778114 GLW G Fax: (041) 440 4001

Barr and Stroud Automatic Muzzle Reference System

Development/Description

The automatic muzzle reference system has been designed and developed as a complement to tank fire control systems which have either no muzzle reference facility at all or only a manual method of introducing line-of-sight corrections to compensate for changes in muzzle position.

The system is designed for external mounting on an AFV and enables muzzle reference corrections to be made at the commencement of an engagement sequence, without any operator action, and independent of gun elevation.

The system comprises:

- (a) a mirror mounted on the gun muzzle
- (b) a compact optical/electronic unit which is mounted on the gun mantlet. This contains a near Infra-Red (IR) source which projects a collimated beam onto the gun muzzle mirror. The beam is reflected back onto an electro-optic position sensor adjacent to the near-IR source, the outputs from which are processed electrically to produce X and Y signals suitable for transmission to the fire control system. A Built-In Test Equipment (BITE) facility gives the functional status by deriving a signal from the monitoring of specific system parameters
- (c) cabling to interface with the fire control system.

For those applications where there is no fire control computer a separate control and display unit can be provided. This allows the operator to control the automatic muzzle reference system manually and provide a digital read-out of the gun muzzle position. Other options include the provision of a wash/wipe facility and the use of either a parallel or serial digital interface to suit specification applications.

SPECIFICATIONS

DIMENSIONS POWER SUPPLY ACCURACY

INTERFACE

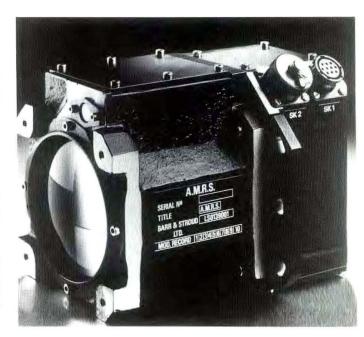
28 V DC better than 0.1 mil over ±3 mils analogue, with variable volts per mil

175 x 140 x 140 mm

scanning factor

CONTROLS TTL enable signal to activate IR source as

required



Barr and Stroud Automatic Muzzle Reference System

Status: Production as required.

Manufacturer: Barr & Stroud Limited, 1 Linthouse Road, Glasgow G51

4BZ, Scotland, UK.

Telephone: (041) 440 4000 Telex: 778114 GLW G Fax: (041) 440 4001

GEC Sensors Multisensor Platform

Development/Description

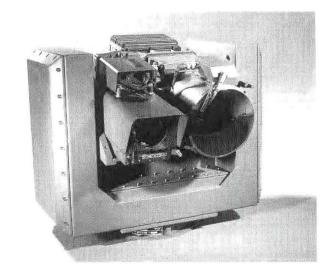
The Multisensor system is based on GEC Sensors long-range, compact SS600 Thermal Imager combined with a chosen set of complementary multispectral sensors to provide surveillance and target range information in both day and night, and through smoke, haze and poor visibility conditions.

The SS600 Thermal Imaging System incorporates technology from GEC's coaxial Thermal Imaging System currently in service with the British Army on its High Velocity Missile system on the Stormer vehicle air defence vehicle and Lynx helicopter Night Enhancement Programme for the TOW missile system. The use of this technology is incorporated with electronic picture magnification, noise reduction and freeze frame facilities to offer a high performance system within the specified space envelope.

The Multisensor payload is mounted on a stabilised steerable platform which can be installed on a variety of platforms including vehicles. The platform provides a full 360° field-of-regard with a fast slew rate, while the option of stabilisation neutralises the effects on the sensors from any external vibration or movement.

The system can be mounted on both tracked and wheeled military vehicles to provide the crew with long-range target detection, recognition, identification and ranging. The design of the system also ensures that a variety of payloads can be integrated and boresighted on the platform with a minimum requirement for static balance.

Control of the platform and sensors is through an RS422 serial data link to reduce the number of connections between the console and platform to a single cable. The crew station console provides full control for the platform and its chosen sensors, together with a selection of high resolution ruggedised monitors, to display their images.



GEC Sensors Multisensor platform

Status: Ready for production.

Manufacturer: GEC Sensors Ltd, Electro-Optical Military Division, Christopher Martin Road, Basildon, Essex SS14 3EL, UK.
Telephone: (0268) 522822 Telex: 99225 Fax: (0268) 883140

GEC Sensors Tank Thermal Sensor (TTS)

Development/Description

The modular 8-13 µm waveband region Tank Thermal Sensor (TTS) system is based on technology from the United Kingdom Thermal Imaging Common Modules (TICM II) programme and is a passive imaging sight providing day and night capability for target detection, recognition and tracking purposes.

It can be fitted either as a new-build item or as a retrofit vehicle installation, and be integrated into a fire control system.

The telescopes and displays can be selected by system designers to meet the operational requirements and vehicle type. Variants of the TICM II programme are also used in the Chieftain and Challenger 1 MBT Thermal Observation and Gunnery System (TOGS) (qv) and on the Warrior Mechanised Armoured Observation Vehicle.

SPECIFICATIONS

WEIGHTS sensor head commander's display processing electronics unit DIMENSIONS sensor head commander's display processing electronics unit WAVEBAND REGION TELESCOPES

MAGNIFICATION

FIELD-OF-VIEW
× 10 magnification type telescope
× 5 magnification type telescope
DETECTOR
DETECTOR COOLING

POWER SUPPLY GUNNER'S DISPLAY eyepiece resolution screen COMMANDER'S DIRECT VIEW DISPLAY resolution

screen

13.5 kg 3.4 kg

9 kg

9 kg

 $355 \times 230 \times 325 \text{ mm}$ $130 \times 175 \times 290 \text{ mm}$ $195 \times 130 \times 95 \text{ mm}$

8-13 μm

standard range of fixed, dual or

zoom types

range \times 2 to \times 20 according to

type

6 × 4°

12 × 8°

8 parallel CMT 'Sprite' closed cycle split Sterling engine 28 V DC vehicle system

× 7.8 magnification 600 lines

25.4 mm electrostatic CRT

350 lines

76.2 mm electro-magnetic CRT



GEC Sensors Tank Thermal Sensor (TTS) System



GEC Sensors TICM II based Thermal Sensor System for the Warrior Mechanised Armoured Observation Vehicle

 ${\bf Status:}\ {\bf TTS}\ {\bf ready}\ {\bf for}\ {\bf production}.\ {\bf TICM}\ {\bf II}\ {\bf version}\ {\bf for}\ {\bf British}\ {\bf Army}\ {\bf MAOV}\ {\bf in}\ {\bf production}\ {\bf phase}.$

Manufacturer: GEC Sensors Ltd, Electro-Optical Military Division, Christopher Martin Road, Basildon, Essex SS14 3EL, UK.
Telephone: (0268) 522822 Telex: 99225 Fax: (0268) 883140

GEC Sensors SS100/SS110 Night Sights

Development/Description

The SS100 (British Army designation SPAV L2A1) and SS110 (British Army designation SPAV L3A1) first-generation binocular vision, dual field-of-view, image intensifier sights were designed respectively for use with the Fox CVR(W) and Scorpion CVR(T) armoured vehicles.

The equipment is turret-mounted in front of the gunner and alongside the main armament. It enables the gunner to locate, identify and engage targets at night without the use of artificial illumination.



GEC Sensors SS100 sight installed in CVR(W) Fox with sight mounted to right of 30 mm RARDEN cannon. When not required sight face is covered by an armoured shutter

A dual role capability is achieved by the use of two objectives, mounted one within the other. The outer objective gives a magnification of \times 5.8, while the inner, for surveillance, has a magnification of \times 1.6.

When the higher power magnification is in use a shutter isolates the low power objective and when the low power is selected an iris diaphragm isolates the high power lens.

The image intensifier tube is of the first-generation 25 mm cascade type and is protected from the effects of muzzle flash by a shutter which is electrically operated by the gun firing circuit. Automatic brightness control for the tube is also fitted.

An illuminated ballistic ring graticule with brightness control is injected automatically into the optical system when the high magnification is used, and this is used for laying the Royal Ordnance 30 mm L21 RARDEN or 76 mm L23A1 main armament.

SPECIFICATIONS (SS100 and SS110)

WEIGHT (total) 59 kg
DIMENSIONS

sight unit $1120 \times 355 \times 355$ mm electronic control box $108 \times 165 \times 295$ mm

FIELD-OF-VIEW

× 5.8 magnification 8° × 1.6 magnification 28°

POWER SUPPLY 28 V DC vehicle system

Status: SS100 production as required. In service with the British Army and other countries.

SS110 production as required. In service with the British armed forces and other countries.

Manufacturer: GEC Sensors Ltd, Electro-Optical Military Division, Christopher Martin Road, Basildon, Essex SS14 3EL, UK.
Telephone: (0268) 522822 Telex: 99225 Fax: (0268) 883140

GEC Sensors SS120 Commander's Night Sight

Development/Description

The SS120 (British Army designation No 37N) was designed to be interchangeable with the commander's periscope sight AV No 37 Mk 4 on the Chieftain MBT.

It provides night surveillance, target acquisition and, if used with a PRI AV No 22 or No 24, has a ballistic graticule and IFCS aiming mark injected into its field-of-view enabling the tank commander to lay the 120 mm L11 main armament.

For sighting the secondary machine gun an aiming mark is available on the night vision eyepiece graticule whilst for the day periscope an injected aiming mark is used with a circle defining the field of the night sight system.

A tilting head mirror is connected by a half-speed linkage to a lever arm actuated by the machine gun mountings AC No 8 and 10. The head assembly also houses the boresighting mask and injects the PRI into the sight optics.

The image intensifier tube used is an 18 mm second-generation wafer type and can be replaced by a third-generation Gallium Arsenide (GaAs) type to ensure an extended, no modification, life cycle. A shutter system is used to protect the tube against muzzle flash at night and, when switching to the day unit periscope, the shutter is automatically closed by mechanical means.

A set of four filters – night/full moon, full moon/twilight, twilight/dull day and dull day/full sunlight – allows the commander to use the sight as a standby observation system in full sunlight.

SPECIFICATIONS

WEIGHT 24.8 kg

DIMENSIONS $285 \times 337 \times 560 \text{ mm}$

ELEVATION RANGE -10 to +30°

Day periscope

MAGNIFICATION × 1
FIELD-OF-VIEW 35° min
Night vision system

MAGNIFICATION × 5
FIELD-OF-VIEW 8°

POWER SUPPLY 28 V DC vehicle system

Status: Production as required. In service with the British Army and other unspecified countries.

Manufacturer: GEC Sensors Ltd, Electro-Optical Military Division, Christopher Martin Road, Basildon, Essex SS14 3EL, UK.

Telephone: (0268) 522822 Telex: 99225 Fax: (0268) 883140



GEC Sensors SS120 Tank Commander's Night Sight for Chieftain MBT from commander's side

GEC Sensors SS122 Series Armoured Vehicle Day/Night Sights

Development/Description

The SS122 and its associated series of derivatives (SS123 – SS126) are designed for fitting to the gunner's and commander's turret positions of most current armoured fighting vehicles.

The SS122 consists of an optical system which provides the operator with a \times 9.3 magnification fixed focus day system that has detection, recognition and identification ranges in clear atmosphere of 30 000, 15 000 and 7000 m respectively, a \times 9 magnification variable focus night system with detection, recognition and identification ranges respectively of 1800, 900 and 450 m at 10^3 lux, and a unity magnification fixed focus general daylight observation facility.

Switching from the 25 mm three-stage cascade type image intensifier passive night vision system to day vision is instantaneous, allowing the sight to provide a 24 hour target engagement capability. The eyepiece has integral laser absorption filters to protect the operator's eyes against incoming laser shots.

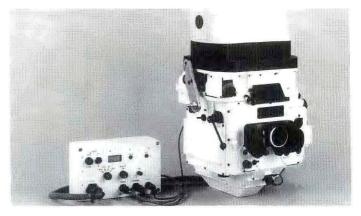
Elevation of the line-of-sight is performed by a tilting head mirror. In the case of the gunner's versions this is linked mechanically to the main armament whilst with the commander's variants it is manually operated and fully independent of the gunner's sight.

If required, a GEC Ferranti Defence Systems Type 520 Nd-YAG or Simrad LV353 Nd-doped laser rangefinder module can be integrated into the sight assembly as an optional extra. When fitted to a sight in the vehicle, the range information can also be transmitted to either the other operator's sight or a remote display unit.

The sight series can also be provided with a fire control computer which generates a moving aiming mark within the sight. Known as the SS123FC Computerised Fire Control System, it integrates the two main turret subsystems – the fire control and sighting elements – to form a complete optimised fire control system.

The main components of the SS123FC are:

- (a) ballistic computer which provides the interface between the system, main armament, laser rangefinder, sensors, gun position encoder and the sight displays
- (b) commander's control panel which is part of the computer unit and provides the interface between the commander and the ballistic computer
- (c) trunnion tilt sensor which provides the computer with the angle at which the trunnion lays in order for a correction to be calculated for moving the gun aiming mark position
- (d) turret angle sensor which measures the angle turned by the turret over a measured time and is sent to the computer to use with the target range data so that the target position when the round impacts can be calculated
- (e) gunner's SS122 series gunner's sight with day/night vision and laser rangefinding capabilities. If required, the sight can be interfaced with more sophisticated ballistic computers provided by other companies



GEC Sensors SS122 Series Armoured Vehicle Day/Night Sight

(f) commander's SS122 series sight which can be provided with duplicate inputs from the computer in order to permit him to engage targets.

SPECIFICATIONS (typical)

WEIGHT	
sight	44 kg
control box	4 kg
laser rangefinder module	3 kg
DIMENSIONS	360 × 350 × 625 mm
POWER SUPPLY	28 V DC vehicle system
Unity day sight	121
MAGNIFICATION	× 1
FIELD-OF-VIEW	
horizontal	25°
vertical	10°
Day vision channel	
MAGNIFICATION	× 9.3
FIELD-OF-VIEW	6.4°
Passive night vision channel	
MAGNIFICATION	× 9

FIELD-OF-VIEW 6.5°
FOCUS RANGE 30 m to infinity

DIOPTER RANGE fixed (-1.75)

Status: Production, over 1200 produced to date. In service with at least 11 countries.

Manufacturer: GEC Sensors Ltd, Electro-Optical Military Division, Christopher Martin Road, Basildon, Essex SS14 3EL, UK.
Telephone: (0268) 522822 Telex: 99225 Fax: (0268) 883140

GEC Sensors SS141, SS142 Commander's Night and SS162 Commander's Day Vision Periscopes

Development/Description

The SS141 commander's bi-ocular fixed head passive night vision periscope can be fitted into 130 \times 70 mm fitting apertures on most turreted light armoured vehicles. It uses a second-generation 20/30 ABC type microchannel plate image intensifier tube with a typical target detection range of 1320 m, recognition range of 330 m and identification range of 170 m against a 2.3 m² target in clear starlight (10 3 lux).

The use of an integrated 0, 2, 4 and 6 Neutral Density filter selector allows daylight use in an emergency.

The SS142 commander's night vision sight is virtually identical to the SS141 in most respects but is fitted with an elevating head assembly for use against low-flying airborne targets such as helicopters and requires a 170×90 mm fitting aperture.

The SS162 commander's monocular day periscope is designed as an interchangeable unit for the SS142 sight. It employs refractor type optics with an elevating head assembly and an additional unity magnification reflector type periscope with a bi-ocular viewing window. The monocular eyepiece has integrated laser protection filters to protect the observer.



SPECIFICATIONS WEIGHT

7 kg SS141 SS142 8.2 kg SS162 5 kg

ELEVATION RANGE

SS141 fixed -10 to +20° SS142 SS162 -10 to +20°

FIELDS-OF-VIEW

SS141 × 2.7 magnification 13.3°

× 2.7 magnification 13.3°

SS162

× 1 magnification 30.3 × 13.1°

× 3 magnification POWER SUPPLY 139

28 V DC vehicle system

Status: Production. In service with unspecified countries.

Manufacturer: GEC Sensors Ltd, Electro-Optical Military Division,

Christopher Martin Road, Basildon, Essex SS14 3EL, UK. Telephone: (0268) 522822 Telex: 99225 Fax: (0268) 883140

GEC Sensors SS180 Armoured Vehicle Day/ Night Sight

Development/Description

The SS180 is designed as a commander's and/or gunner's elevatable sight for use on light armoured fighting vehicles and armoured personnel carriers. The commander's variant can be fitted with a circular slew ring with a ±30° azimuth arc rotation and indexing plunger to lock the sight in line with the main armament.

To allow for an uninterrupted target engagement capability the SS180 can be switched instantly by hand lever from day to night vision operation. Both modes feature injected illuminated ballistic graticules with boresight and brightness adjustment for targeting purposes.

An electro-mechanical shutter protects the second-generation image intensifier tube during daylight operations whilst absorption filters in the eyepiece and unity-magnification vision channels provide laser protection for the observer.

The SS180 can be supplied fitted with a third-generation image intensifier tube

SPECIFICATIONS

ELEVATION RANGE -10° to +55° Unity day reflecting telescope MAGNIFICATION $\times 1$ FIELD-OF-VIEW horizontal 300 vertical High magnification refracting day vision channel

MAGNIFICATION × 5 FIELD-OF-VIEW Night vision channel MAGNIFICATION × 5 FIELD-OF-VIEW 80

OPERATIONAL RANGES

(in starlight) (m) detection 1350 recognition 750 identification 520

POWER SUPPLY 28 V DC vehicle system

Status: Production. In service with unspecified countries.



GEC Sensors SS180 Armoured Vehicle Day/Night Vision Sight from operator's

Manufacturer: GEC Sensors Ltd, Electro-Optical Military Division, Christopher Martin Road, Basildon, Essex SS14 3EL, UK.

Telephone: (0268) 522822 Telex: 99225 Fax: (0268) 883140

GEC Sensors SS500 Series Armoured Vehicle **Thermal Sights**

Development/Description

The SS500 series is supplied in two major versions: either as the complete SS500 periscopic day/thermal sight or the SS550 thermal imaging elbow. Both are designed for installation in a wide range of armoured vehicles from light armoured cars through to MBTs as retrofit or new-build items

The SS500 is a complete sighting system that incorporates an 8-13 µm waveband region GEC Sensors thermal imager system with a high magnification day channel, thermal CRT display and Nd-YAG 1.064 μm laser rangefinder, such as the GEC-Ferranti Defence Systems Type 520.

The day and thermal imager channels are viewed through a common eyepiece and are instantly changeable. If needed, a tailored fire control computer interface can also be incorporated into the system.

The thermal imaging system comprises the following subsystems:

- (a) scanner unit which contains the scan mechanism with associated optics, the 'Sprite' (Signal Processing In The Element) detector and cryogenic cooling head, the scanner drive and detector head amplifier modules
- (b) dual field-of-view telescopic unit
- (c) processing electronics unit which contains the electronics necessary to convert the infra-red signals from the scanner to a video signal for single or multiple display(s).

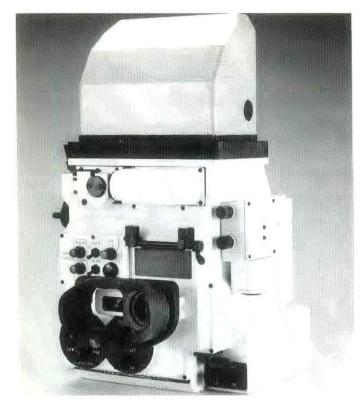
It also contains the AC/DC converter module to power the image and space for two optional extra card modules. The first of these is the autocontrol module which provides automatic optimisation of the gain and window settings. An indication of the settings is provided on the display screen(s) for both the automatic and manual operating modes. A graticule display, which can be steerable if required, is provided.

The second option is the video insertion module which will provide. according to customer requirements, a range of alphanumeric information from external sources together with complex graticule patterns and/or graphics information

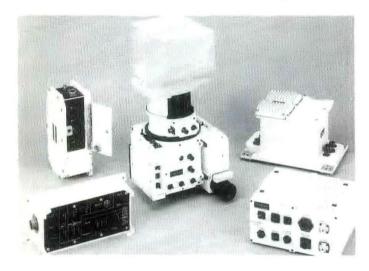
- (d) display unit which provides the 352-line TV display of the converted thermal image on a 25.4 mm standard CRT module. This is viewed through an eyepiece with provision made for an additional remote display to allow both the vehicle commander and gunner to observe the scene simultaneously. If the auto-control module is fitted the control settings are also displayed
- (e) controls which are located on the sight body
- detector cooling services which can either be high pressure gas supplied from bottles or from a compressor. A cooling engine option is also available

The SS550 thermal elbow uses the same thermal imaging technology as the sights and is designed for installation on a range of head units and, with some modification, can replace the image intensifier elbows fitted to many of the M- and T-series MBTs.

The elbow is designed to interface with fire control systems and laser rangefinders and, when a servo driven head is fitted, the sight unit can be mounted in any suitable position within the turret, the crew then being provided with remote display/control modules



GEC Sensors SS500 Model Armoured Vehicle Thermal Sight



The major components of an SS550 elbow sight package, designed for use in the Chinese Type 59 MBT with a Marconi Centaur weapon control system to provide a total weapon control capability by day and night as well as in adverse conditions, are:

- (a) sight module with dual field-of-view × 3 and × 10 magnification telescope, scanner unit and detector cooling engine
- (b) processing electronics unit which comprises all the processing electronics as used in the SS500 sight together with the auto-control module. The latter also generates two reversionary ballistic graticule patterns to allow continued use of the thermal elbow in the event of the fire control computer failing
- (c) gunner's module with a 25.4 mm monocular display, a boresighting unit to allow alignment of the reversionary graticules with the main armament and the elbow control panel
- (d) optional commander's 25.4 mm display with bi-ocular viewer to allow the commander to see the same view as the gunner.

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WEIGHT (total)	40 Kg	
DIMENSIONS	430 × 360 × 625 mm	
Day channel		
FIELDS-OF-VIEW		
× 1 magnification	horizontal	23°
	vertical	20°
× 9 magnification		4.7
Thermal channel		

WAVEBAND REGION 8-13 µm

FIELDS-OF-VIEW × 3 magnification horizontal 13.3° vertical 8.5° × 10 magnification horizontal 4° vertical 2.6° POWER SUPPLY 28 V DC vehicle system

SPECIFICATIONS (SS550)

POWER SUPPLY

WEIGHTS	4
elbow sight assembly (including display)	13.5 kg
processing electronics unit	9 kg
elbow sight assembly (including display)	320 × 228 × 322 mm
Thermal channel	
WAVEBAND REGION	8-13 μm
FIELDS-OF-VIEW	
× 3 magnification	horizontal 13.3° vertical 8.5°
× 10 magnification	horizontal 4° vertical 2.6°

Status: SS500 in production. In service with unspecified countries. SS550 in production. In service with unspecified countries.

Manufacturer: GEC Sensors Ltd, Electro-Optical Military Division, Christopher Martin Road, Basildon, Essex SS14 3EL, UK. Telephone: (0268) 522822 Telex: 99225 Fax: (0268) 883140

28 V DC vehicle system

GEC Sensors SS550 Model Thermal Elbow Assembly (centre) with Marconi Centaur Weapon Control System as designed for the Royal Ordnance plc Type 59 MBT Retrofit Package

Helio AFV Periscopes

Development/Description

The Helio Mirror Company is a major design authority and manufacturer of unit vision periscopes for AFVs. It has an extensive range of periscopes available for both wheeled and tracked armoured vehicles. A full listing of which and their applications are:

VEHICLE TYPE	PERISCOPES
AS 90	No 106
CET	Vision block
Centurion	No 7 Mk 1, No 8 Mk 1, No 15
Challenger 1	No 30 Mk 1, No 36 Mk 1, No 40 Mk 1, No
	41 Mk 1,
	No 224, No 223, No 202
Chieftain	No 30 Mk 1, No 36 Mk 1, No 40 Mk 1, No
	41 Mk 1, No 45 Mk 1
CR ARRV	No 198
Leopard 1	1900, 5100
M1A2	Commander's Periscope
M41	2100, 2700
M48	2100, 2700

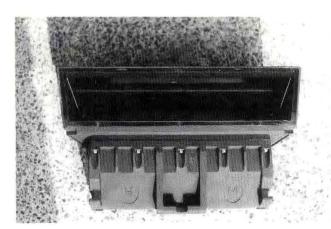
OF-40 1900, 5100 lkv-91 2100 Scorpion No 43 Mk 3, No 44 Mk 1, No 48 Mk 2. Scimitar No 43 Mk 3, No 48 Mk 2

Striker No 42 Mk 1 Sultan No 42 Mk 1, No 44 Mk 1

Spartan No 41 Mk 1 No 42 Mk 1. No 44 Mk 1 Stormer



Helio 2100 periscope



Helio 202-00 periscope

VEHICLE TYPE	PERISCOPES	
Ferret	No 3 Mk 1, No 17 Mk 3	
Fox	No 44 Mk 1	
Saladin	No 17 Mk 3, No 18 Mk 1	

Panhard ERC, Lynx and

Sagaie No 474, No 475
Panhard VCR No 476, No 478, No 479

 Piranha
 2100

 Cougar
 2100

 LAV-25
 1900, 2100

 Shark
 2100

Saracen No 3 Mk 1, No 17 Mk 1 FV432 No 32 Mk 1, No 33 Mk 1

Warrior No 30 Mk 1, No 40 Mk 2, No 44 Mk 1, No 53 Mk 1,

No 202, No 224 2100, 2700, 4500

M113 2100, 270 Pby 302 2100

Tornado 2100

Abbot No 32 Mk 1, No 33 Mk 1 M109 2100, 2700, 4500 The periscopes have glass prisms, mounted in either shatter alloy, aluminium castings or DMC housings. An air gap between the prisms is a design feature to absorb impact and blast from the object prism when struck, so minimising any transfer into the ocular prism. They are also designed to be easily replaced in the field following damage and, in some cases, for field repairs.

In 1988 Helio introduced a new range of unitary periscopes capable of incorporating single and multi-line laser filters. The customer can either purchase a basic unit initially, and retrofit the laser filter at a later date if he so wishes, or buy a complete unit.

Amongst this periscope family are the following types:

NEW MODEL	REPLACEMENT FOR IN-SERVICE UNIT
No 202	No 40 Mk 2
No 223	No 36 Mk 1
No 224	No 41 Mk 1
No 42 Mk 2	No 42 Mk 1
No 44 Mk 4	No 44 Mk 2
No 2100	M17
No 2700	M27
No 4500	M45

No modifications are necessary to the vehicles in order to accommodate the new models.

Optional design features which can be built in to a model include such special features as non-reflection of incident light, inner face black out blinds to prevent egress of light from within the vehicle during night time surveillance, stabilised glass to maintain vision after nuclear flash, polycarbonate windows for greater spall protection, wipeable and replaceable front windows, a wash/wipe facility and brow pads.

To complement the periscope range Helio is also a design authority and manufacturer of ballistic and non-ballistic cowls with and without heated windows and wash/wipe systems.

Status: Production. In service with the British Army and numerous undisclosed countries.

Manufacturer: Helio Mirror Company Ltd, Crabtree Manorway South, Belvedere, Kent DA17 6AY, UK.

Telephone: (081) 311 4140 Telex: 8951666 Fax: (081) 311 1004

Marconi Gunner's Thermal Imaging Vehicle Sight (TIVS)

Development/Description

The TIVS is a lightweight, miniaturised high performance self-contained thermal imaging module. Its size enables it to be easily coupled with a range of vehicle gunner's sights to provide a totally integrated day/night all-weather sighting system.

Three fields-of-view are offered with a standard TV video format picture that can be relayed onto other vehicle operators. Cooling is provided by an integrated closed cycle Sterling engine.

SPECIFICATIONS

WAVEBAND REGION 8-12 μm FIELDS-OF-VIEW

 $\begin{array}{lll} \mbox{wide} & 11 \times 8.5^{\circ} \\ \mbox{narrow} & 3.9 \times 1.5^{\circ} \\ \mbox{zoom} & 2.0 \times 1.5^{\circ} \end{array}$

DISPLAY FORMAT TV CCIR; monocular/binocular/relaxed view

monitor

COOLING closed cycle Sterling engine

POWER CONSUMPTION 65 watts

Status: In production. In service with Turkish Army (initial batch of 217 being supplied to FMC-Nurol Savunma Sanoyii SA (FNSS) for Armored Infantry Fighting Vehicle (AIFV)).

Manufacturer: Marconi Radar and Control Systems Ltd, Chobham Road, Frimley, Camberley, Surrey GU16 5PE, UK.

Telephone: (0276) 63311 Telex: 858289 Fax: (0276) 695498

Marconi Radar and Control Systems gunner's Thermal Imaging Vehicle Sight (TIVS)

L20 Series Sight Laser NANOQUEST Rangefinders

Development/Description

The L20 series are designed to be modular periscopic sight laser rangefinder units for gunners to increase their first round hit probability, reduce the overall engagement time and maximise operational efficiency by introducing savings in ammunition expenditure, logistics, maintenance actions and overall life cycle costings.

By using a special-to-type optical head and adaptor unit, versions of the L20 can be fitted to the gunner's sight mountings in Centurion, Chieftain, Challenger 1, Vickers Mk 3 and Vijayanta MBTs as well as the M41 light tank and Scorpion tracked armoured reconnaissance vehicle.

The L20 options available are:

AFV Type	Las	ser*	CRR	RLFF	FCSI	LTM	MRS
	Type 520	LV352					
MBT							
Chieftain	Y	Υ	Y	Y	Y	Y	Y
Challenger 1	Υ	Y	Y	Y	Y	Y	Y
Centurion	Y	Y	Y	Y	Y	Y	F
Vijayanta	Υ	Υ	Y	Y	Y	Y	F
Vickers Mk 3	Y	Y	Y	Y	Y	Y	Y
Light tank							
M41 Bulldog	Y	Y	Y	Y	Y	Y	F
CVR(T)							
Scorpion	Y	Y	Y	Y	Y	Y	N

KEY

* The laser rangefinder modules available are either the GEC-Ferranti Type 530 Mk2 or Simrad LV352.

CRR = Commander's Range Readout

RLFF = Remote Laser-Firing Facility

FCSI = Fire Control System Interface - for built-in digital data link and built-

in CRT for aiming mark injection LTM = Laser Training Module

MRS = Muzzle Reference System

Y = yes

N = no F = feasible

The L20 family members comprise three main modules: the optics, laser and electronics. If either the laser module or the electronics module becomes unserviceable then the faulty unit can be removed for repair from the in situ sight and the operator continues his operations in the reversionary mode. Stowage of models is feasible and can provide a way of immediate return to full operational capability.

Main operating features of the various models, which only differ in the type of laser rangefinder installed and the optical head/adaptor units, can be summarised as Nd-YAG transceiver with the range readout displayed in the gunner's eyepiece and cathode ray tube to provide controlled aiming mark when linked to a fire control system. In addition, the CRT displays the output from a remote thermal imager or Low Light Level Television (LLLTV) camera. The sight is provided with a × 10 magnification channel for gunnery and an integral periscopic unity surveillance channel for general observation.

SPECIFICATIONS Sighting Telescope

oighting releacope	
MAGNIFICATION	× 10
EXIT PUPIL DIAMETER	4 mm
FIELD-OF-VIEW	120 mils
TRANSMISSION (eye response weighted)	40%
FORESIGHT ADJUSTMENT	+ 10 mils

PARALLAX BETWEEN IMAGE OF

TARGET AT INFINITY, GRATICULE AND CRT SPOT -0.15 mil max

MISALIGNMENT BETWEEN

OPTICAL LASER SIGHT LINES -0.15 mil max

Acquisition periscope

MAGNIFICATION

FIELD-OF-VIEW fixed eve dynamic horizontal 480 mils 765 mils vertical 125 mils 230 mils Laser rangefinder

SIMRAD LV352 **GEC-Ferranti Type** MANUFACTURER 520 Mk II

TYPE second-generation Nd-YAG WAVELENGTH 1.064 µm **OUTPUT ENERGY** 15 MJ 20·MJ RAW BEAM DIAMETER 4 mm 4.2 mm **CLOCK FREQUENCY** 30 MHz LOGIC first/last pulse

OPERATING RANGE 200-9995 m 300-9995 m ACCURACY PULSE REPETITION RATE 0.5 pps 1 pps

DUTY CYCLE 3 pulse/15 s continuous POWER SUPPLY 28 V DC

Status: Production as required.

Manufacturer: NANOQUEST Defence Products Limited, Green Park Business Centre, Sutton-on-the-Forest, York YO6 1ET, UK.

Telephone: (0347) 811234 Fax: (0347) 811213

NANOQUESTL50 Series Sight Laser Rangefinders

Development/Description

The L50 Series gunners' sight laser rangefinder conversion units have been designed for installation on the T-55 and Type 59 MBTs by directly interfacing with the existing gunner's telescope.

Their operational advantages include improving the first round hit probability, reducing overall engagement time, covert operation and reduction in ammunition expenditure.

The L50 series comprises three or four module units depending on the build standard. These are the optics module (conversion kit) or laser module, range display and control module and aiming mark injection module (build standard dependent).

In the low-cost build standard the sight provides a laser rangefinder capability for the conventional mechanical fire control systems of the T-55/ Type 59. In its standard build state the sight provides laser rangefinding and aiming mark injection for available computer based fire control systems.

Common optics ensure harmonisation of the sight channels, laser pathway and injected aiming mark. A CRT provides the computer controlled aiming mark when linked with the computer based fire control system. The CRT may also be utilised for the output from a remote thermal imager or Low Light Level Television (LLLTV) camera.

The sight's telescope has dual magnification for gunner (× 8 magnification) and surveillance (x 4 magnification).

An optional commander's range display module is also available. This display can be used to upgrade the low-cost build standard up to the standard build level if required at a later stage.

Status: Production as required.

Manufacturer: NANOQUEST Defence Products Limited, Green Park Business Centre, Sutton-on-the-Forest, York YO6 1ET, UK.

Telephone: (0347) 811234 Fax: (0347) 811213

SPECIFICATIONS

WEIGHT	15 kg
MAGNIFICATION	
high	×8
low	× 4
FIELD-OF-VIEW	

140 mils high 280 mils low EYE RELIEF 27 mm min

PARALLAX BETWEEN IMAGE OF TARGET AT INFINITY AND

GRATICULE

0.15 mil max TRANSMISSION 20% min BORESIGHTING ADJUSTMENT,

VERTICAL AND HORIZONTAL +17 mils min

DISPLAYS (four digits) multiple targets, ammunition type, first/last logic, objective heater on and power on

Laser rangefinder module SIMRAD LV352 **GEC-Ferranti Type** 520 Mk II

TYPE second generation Nd:YAG WAVELENGTH 1.064 µm **OUTPUT ENERGY** 15 MJ 20 MJ RAW BEAM DIAMETER 4.2 mm 4 mm **CLOCK FREQUENCY** 30 MHz

LOGIC first/last pulse **OPERATING RANGE** 200-9995 m 300-9995 m

ACCURACY ±5 m PULSE REPETITION RATE 0.5 pps 1 pps DUTY CYCLE 3 pulse/15 s continuous POWER SUPPLY 28 V DC

Pilkington Optronics Condor Commander's Day/ Night Sighting System

Development/Description

The Condor sighting system was developed to provide the tank commander with 24 hour surveillance, target acquisition, observation of fall short and the firing of the main armament capability in either manual or fire control system modes of operation.

The Condor sight is of the periscopic type with day/night vision channels that are viewed through a common binocular eyepiece. The sight is physically linked to the commander's machine gun to permit elevation and depression of its line-of-sight.

It can either operate independently or be interfaced to one of a number of tank fire control system types.

The sight is provided with a unity-magnification window providing a target acquisition facility. The × 10 magnification day channel has a 5° field-of-view enabling accurate aiming of the main armament to take place as well as long range identification of targets. The passive night vision channel has a \times 4 magnification and a 9° field-of-view to enable target acquisition and engagement at ranges in excess of 1500 m under starlight conditions.

SPECIFICATIONS

HEIGHT 643 mm (330 mm above armour)

WIDTH 330 mm DEPTH 537 mm

MIN APERTURE SIZE

IN ARMOUR 236 mm × 115 mm

MAX ELEVATION OF LINE-OF-SIGHT

+35 MAX DEPRESSION OF

LINE-OF-SIGHT -10°

Day sight

MAGNIFICATION $\times 10$ FIELD-OF-VIEW 50 Night sight

MAGNIFICATION × 4 FIELD-OF-VIEW 90

RECOGNITION RANGE 1500 m (MBT)

800 m (man)

DETECTION RANGE up to 4000 m (MBT) 28 V DC (vehicle supply) **POWER SUPPLY**

POWER CONSUMPTION 140 W (max)

Status: Production as required. In service on Khalid MBT (Jordan), Vickers Mk 3 MBT (Kenya and Nigeria) and trialled on other tanks including M41 and Chieftain.



Pilkington Optronics Condor commander's day/night sighting system from

Manufacturer: Pilkington PE Ltd, Glascoed Road, St Asaph, Clwyd LL17 OLL. UK

Telephone: (0745) 588000 Telex: 61430 Fax: (0745) 584959

Pilkington Optronics Raven Combined Day/Night Sight

Development/Description

The Raven combined day/night sight was developed by Pilkington PE to provide commanders and gunners of MBTs and light armoured vehicles with a 24 hour day/night capability. It can be used for surveillance, target acquisition, firing main armament and observation of fall of shot. It is in full scale production for the GKN Defence Warrior mechanised combat vehicle for the British Army, with first production sights of the 422 ordered being completed late in 1986.

Late in 1986 it was announced that, as a result of competitive tendering, Avimo had been awarded a contract worth over £17 million for the second production batch of Raven day/night sights for the Warrior mechanised combat vehicle, totalling some 1600 sights.

The Raven day/night sight has been designed for installation from under or above armour and a lifting frame is supplied as an aid to installation and removal. It has been designed to interface directly with the gun via a linkage on the right side of the sight, when looking forwards.

The sight has graticule adjusters that enable the sighting system to be boresighted to the main armament and separate adjustments are provided for boresighting the \times 1 and magnified day and night channels.

The Raven sight is a combined day/night sighting system and comprises three viewing channels, a fixed focus magnified day channel, a dual fieldof-view second- or third-generation image intensified night channel and a unity power day periscope.

The magnified day and image intensified night channels are viewed through common eyepieces with selection of day or night surveillance being effected by a single changeover lever. A focus control and light control iris are also provided in the night channel. The unity power periscope is viewed through a window above the eyepieces.



The three channels view the scene under surveillance via an upper mirror, the elevation and azimuth lines of sight, which are harmonised to the bore line of the main armament.

In order to provide the facility for main armament engagement the sight embodies three separate graticules, one in each channel. All are separately adjustable in elevation and azimuth to achieve accurate boresighting

SPECIFICATIONS

HEIGHT	560 mm
WIDTH	350 mm
DEPTH	450 mm
WEIGHT	50 kg
MANY EL EVATION OF	

MAX ELEVATION OF LINE-OF-SIGHT MAX DEPRESSION OF

LINE-OF-SIGHT -12°

Day sight

MAGNIFICATION \times 1 and \times 8 RECOGNITION RANGE 3000 m **DETECTION RANGE** 5000 m

Night sight

MAGNIFICATION \times 2 and \times 6 RECOGNITION RANGE 1000 m DETECTION RANGE 2500 m

POWER SUPPLY 28 V DC (vehicle supply)

Status: In production. In service with British Army (on Warrior MICV - two sights, one for gunner and one for commander (latter with additional traverse)).

Manufacturer: Pilkington PE Ltd, Glascoed Road, St Asaph,

Clwvd LL17 OLL, UK.

Telephone: (0745) 588000 Telex: 61430 Fax: (0745) 584959

Pilkington Optronics Osprey Combined Day/Night Laser Sight

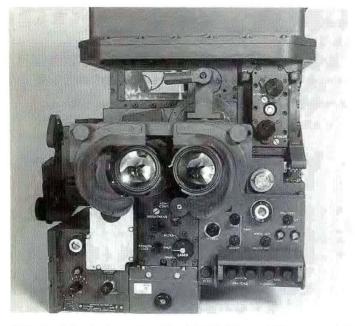
+470

Development/Description

The Osprey is a combined day/night laser sight of modular construction to enable it to be installed in different vehicles for different applications. It has been adopted by the British Army for installation in the Warrior Mechanised Artillery Observation Vehicle (MAOV).

In this application the observer has an Osprey combined day/thermal/ laser system with magnifications of \times 1 and \times 8 in the day mode and built-in laser protection. The assistant will have a Pilkington Raven day/night sight as fitted to the standard Warrior vehicle. Between the observer's and the assistant's positions will be a remote display for the thermal imaging

Optional Osprey facilities include thermal imaging or image intensified



Pilkington Optronics Osprey combined day/night laser sight from operator's side

night vision, laser rangefinder, stabilisation, interfaces to fire control and training simulator systems. Laser and thermal modules can be sourced from a wide variety of specialist manufacturers, according to customer

A typical Osprey configuration for a light AFV would offer a medium elevation head, day channel, thermal channel and a single shot laser rangefinder with built-in displays of thermal scene and laser range, viewed through the twin day channel eyepieces. Remote displays for the thermal and laser information can also be provided.

The Osprey sight can also be configured in an anti-aircraft role by incorporating a high power high repetition rate laser rangefinder in place of the single shot system and adding azimuth stabilisation.

SPECIFICATIONS

ELEVATION RANGE -10° to +20° or -10° to +45° or

-10° to +60°

Day channel

MAGNIFICATION × 8 FIELD-OF-VIEW sinale **EYEPIECES** twin SURVEILLANCE × 1 window

Night channel

THERMAL SCANNER customer choice FIELD-OF-VIEW

dual

COOLING high pressure air or Stirling engine

OUTPUT CCIR TV

IMAGE INTENSIFIER second-generation or

third-generation dual via day eyepieces

OUTPUT

Fire control interface

AIMING MARK

INTERFACE

FIELD-OF-VIEW

digital, RS422 Laser rangefinder

Nd-YAG TYPE WAVELENGTH 1.064 um

Displays THERMAL LASER

via day eyepieces and/or remote via day eyepieces and/or remote

Status: Production. In service with British Army (on Warrior MAOV).

Manufacturer: Pilkington PE Ltd, Glascoed Road, St Asaph, Clwyd LL17

Telephone: (0745) 588000 Telex:61430 Fax: (0745) 584959

Pilkington Optronics Sabre Day and Day/Night Vehicle Sights

Development/Description

The Sabre day and day/night vehicle sights were developed as a private venture by Pilkington PE to meet the market requirement for an inexpensive sight for the commanders and gunners of AFVs.

Sabre is available in dual day or day/night configurations and is suitable for both surveillance and target engagement. It can easily be fitted/retrofitted from above or below armour.

The day version has a unity (\times 1) periscopic channel and a \times 6 magnified channel while the day/night sight has \times 1.5 and \times 6 day channels and a \times 4 night channel. The latter is available with second- or third-generation image intensifier tubes

Both sight options view the scene via an upper mirror, the elevating line-of-sight of which is harmonised to the bore line of the armament by a 2:1 mechanism.

SPECIFICATIONS (day sight)

DIMENSIONS below armour

width 211 mm height 258 mm

depth 84 mm

above armour width 241 mm height 192 mm

depth 145 mm (max) 28 V vehicle supply

30° horizontal, 15° vertical

POWER SUPPLY MAX ELEVATION +50°

MAX DEPRESSION

-15

Magnified day channel MAGNIFICATION

× 6 FIELD-OF-VIEW 6

Unity day channel

MAGNIFICATION

FIELD-OF-VIEW

RECOGNITION FOR A 2.3 m × 2.3 m TARGET

about 4000 m

IDENTIFICATION FOR A 2.3 m × 2.3 m TARGET

about 2500 m

SPECIFICATIONS (day/night sight)

DIMENSIONS

width 211 mm height 258 mm below armour

depth 84 mm

above armour width 241 mm height 192 mm

depth 145 mm (max) 28 V vehicle supply

ELECTRICAL MAX ELEVATION +50°

MAX DEPRESSION

Switchable Magnification

MAGNIFICATION FIELD-OF-VIEW RECOGNITION FOR

A 2.3 m × 2.3 m TARGET **IDENTIFICATION FOR** A 2.3 m × 2.3 m TARGET Day channel Night channel \times 6 and \times 1.5

8.5 6° and 24°

4000 m 600 m 2500 m 800 m

Status: Production.

Manufacturer: Pilkington PE Ltd, Glascoed Road, St Asaph, Clwyd LL17

OLL, UK.

Telephone: (0745) 588000

Telex: 61430

Fax: (0745) 584959



Pilkington Optronics Sabre vehicle sights, night (left) and day (right)

UNITED STATES OF AMERICA

CAI Armoured Vehicle Optical Systems

Development/Description

CAI has produced a number of optical system assemblies for armoured and air defence vehicle applications. These include:

Panoramic Periscope System (P2S) for Armoured Fighting Vehicle commander's, observer's and driver's stations.

The P2S assembly can either be fitted at build or retrofitted to many exisiting armoured vehicle models. It provides a completely unobstructed 360° horizontal field-of-view for an operator, with state-of-the-art ballistic and laser protection. It can also be used in an NBC environment and, with standard issue image intensifier NVG, eliminate the need to use a dedicated night vision periscope.

Status: Production as required.

M1 Abrams MBT Commander's and Gunner's Unity Periscopes

CAI has produced over 27 000 of these M1 periscopes to date for the Abrams MBT programme. The units are due to be upgraded with laser protection filters (see next CAI product).

Status: Production. In service with the US Army and Marine Corps (M1 Abrams MBT).

New Generation Laser Hardened/Ballistic Protected Unity Vision Periscopes

CAI, under a development contract awarded by the US Army's Tank Automotive Command, is developing integrated laser-hardened technology for use on four periscope types currently used on US Army combat vehicles, including the M1 Abrams MBT and the M2/M3 Bradley IFV family

Included in the work are four periscope models used on the M1 Abrams the tall commander, short commander, long driver and short driver position units.

Status: Qualification testing phase.

CA-562 Gunner's Reflex Sight

This sight system is being produced for the US Army's Pedestal-Mounted Stinger (PMS) air defence system.

The gunner sits in a gyrostabilised turret to track the target by direct vision using CAIs optical sight and the PMS's FLIR unit for night and poor weather conditions.

The sight uses a moving reticle which acts as an enhanced visual display

to increase the gunner's confidence level by confirming missile lock-on prior to weapon's launch. It is also utilised as a head-up visual target acquisition system to decrease the overall target acquisition and engagement times.

Status: Production.

Hostile Identification/Targeting System (HITS)

The HITS is designed as a helicopter or air defence vehicle based optoelectronic passive target identification system for identifing targets up to 5000 m range.

It can be mounted on light air defence vehicles and utilises a control panel with CRT display and a shock isolated platform-mounted sensor assembly with video camera and motorised zoom lens.

Status: Production as required.

Manufacturer: CAI Division, Recon/Optical Incorporated, 550 West

Northwest Highway, Barrington, Illinois 60010, USA.

Telephone: (312) 381 2400



CAI Division is developing eye protection for periscopes covering (clockwise, from lower left) tall commander, short commander, long driver and short driver positions

Delco Thermal Sight for the LAV-25

Development/Description

Delco has developed a compact thermal sight for its LAV-25 turret. Designed to fit directly into the existing LAV M36E1 gunner's and/or commander's weapons aiming sight mount, it serially scans the visual scene in both azimuth and elevation and focusses the gathered infra-red energy onto a detector assembly, the output of which is connected to the beam of a television CRT display to produce an optical image for viewing through a monocular eyepiece.

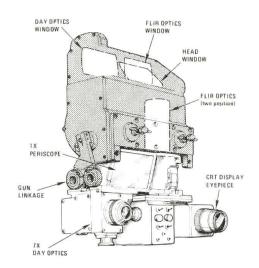
The complete sight assembly also has a unity channel periscope, a \times 7 magnification day channel and a mechanical gun linkage device.

Status: Production.

Manufacturer: Delco Systems Operations, General Motors Corporation, 6767 Hollister Avenue, Goleta, California 93117, USA.

Telephone: (805) 961 5903 Telex: 910 334 1174

Schematic diagram of Delco Systems Thermal Sight for LAV-25 showing major components



Loral International Thermal Sight (ITS)

Development/Description

The Loral International Thermal Sight (ITS) modular sight system has been developed to replace the obsolete active infra-red sight equipment on T-series MBTs and can be used at either the driver's, gunner's or commander's crew station. It has also been successfully installed and field-tested on the Leopard 1 MBT.

It is compatible with digital, analogue and mechanical fire control systems and comprises the following subsystems:

- (a) head assembly
- (b) electronics unit with Loral standard modules

- (c) 8-12 μm waveband region, forward-looking, infra-red thermal imaging, receiver and control unit, with Loral standard modules
- (d) interconnecting cable set
- (e) optional auxiliary commander's viewer unit if the ITS is being used as a gunner's aiming sight.

Status: Production as required.

Manufacturer: Loral Infra-red and Imaging Systems, 2 Forbes Road,

Lexington, Massachusetts 02713, USA.

Telephone: (617) 862 6222 Telex: 923477

Loral Gunner's Day/Night Thermal Tank Periscope Sight (TPS)

Development/Description

The Loral Tank Periscope Sight (TPS) was designed as an interchangeable upgrade system for the M32/M34/M35 gunner's and commander's periscopic sights of the M48A5/M60A1/M60A3 series MBTs. It replaces the active infra-red or passive image intensifier night vision elbow and can also be adapted to other tank types such as the Centurion. The TPS is fully compatible with mechanical, digital or analogue fire control computers.

Based on Loral standard thermal imaging system modules it operates in the 8-12 μm waveband region and uses a 14-element HgCdTe detector with an integral split-Sterling closed cycle cryogenic cooler. Two electronics boxes are fitted within the vehicle, as is an auxiliary commander's display. Fire control status is given on an alphanumeric display on the 525-line video format image with either a standard NATO or customer specified reticle.

SPECIFICATIONS

WEIGHT 47-56.8 kg (depending upon vehicle/sight

type)

FIELDS-OF-VIEW

 $\begin{array}{lll} \text{narrow} \times 5 \text{ magnification} & 2^{\circ} \times 3^{\circ} \\ \text{wide} \times 1.4 \text{ magnification} & 7.5^{\circ} \times 11.5^{\circ} \\ \text{WAVEBAND REGION} & 8-12 \text{ µm} \end{array}$

Status: Production. In service with unspecified countries on M60 series MBTs.

Manufacturer: Loral Infra-red and Imaging Systems, 2 Forbes Road, Lexington, Massachusetts 02713, USA.

Telephone: (617) 862 6222 Telex: 923477

Hughes Gyrostabilised Gunner's Primary Sight (GPS)

Development/Description

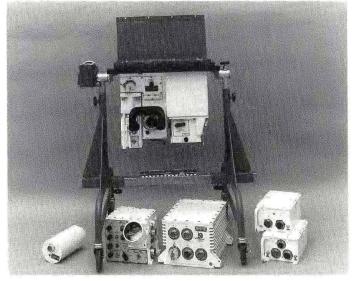
The Hughes two-axis stabilised Gunner's Primary Sight (GPS) was developed for the South Korean Main Battle Tank (Type 88, K-1) in order to provide it with a shoot on-the-move capability in both day and night engagement situations. Hughes M1 production hardware is used as the Thermal Imaging System (TIS) and for the Laser Rangefinder (LRF).

The initial 210 production systems incorporated the Hughes' designed Leopard 2 MBT, two-axis head mirror and a vertical sensor used to furnish roll and pitch dynamics to the computer subsystem. Subsequent orders (for 276 systems) incorporated a fourth generation improved two-axis head mirror and updated electronics.

Status: Production. In service with South Korean Army (Type 88 MBT – as of 1 January 1993 a total of 500 tanks are in service with this system, spares are also being produced).

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems, PO Box 902, El Segundo, California 90425, USA.

Telephone: (310) 616 1022 Telex: 685504



Hughes Gyrostabilised Gunner's Primary Sight for South Korea's Type 88 MBT

Hughes Day/Night Range Sight (DNRS)

Development/Description

The Hughes DNRS was developed under contract to Cadillac Gage Textron for the US Marine Corps' LAV-105 turret and is designed to provide the vehicle gunner with a full shoot-on-the-move capability of engaging enemy targets at extreme ranges in both day and night situations under adverse battlefield conditions.

The modular DNRS comprises the following subsystems:

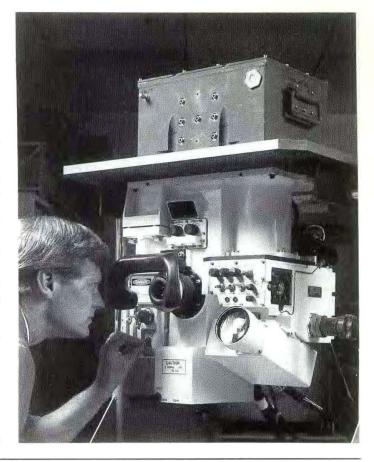
- (a) a Hughes Infra-red Equipment (HIRE) 240-line common thermal imager with programmable reticles and symbology and dual field-of-view (wide $12.3^{\circ} \times 5.1^{\circ}$, narrow $-4.1^{\circ} \times 1.7^{\circ}$)
- (b) a Hughes M1 1.06 μm Nd-YAG laser rangefinder
- (c) a Hughes Line of Sight Stabilisation Platform (LSSP) as used on the South Korean type 88 MBT with an armoured housing for ballistic protection, and a two-axis gyrostabilised head mirror
- (d) a commander's remote display for viewing the day and night sight images and with commander override for all the gunner's controls
- (e) a Line-Of-Sight Electronics Unit (LOS-EU).

The DNRS has a unity window and a × 10 magnification narrow field-of-view for the day sight.

Status: Prototypes delivered to Cadillac Gage Textron. LAV-105 programme has been cancelled but turret may be offered for other applications. Early in 1993 it was reported that LAV-105 programme may be restarted.

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems, PO Box 902, El Segundo, California 90425, USA.

Telephone: (310) 6161022 Telex: 685504



Hughes Aircraft Company Day/Night Range Sight (DNRS)

Hughes GMHE Integrated TOW Sight (GITS)

Development/Description

The modular GITS is designed as an upgrade for small turrets to provide an under armour TOW capability. It contains an improved infra-red sensor with a 60-element HgCdTe detector similar to the AN/TAS-4, -5 and -6. The sensors fields-of-view are large for increased gunner acquisition, tracking and firing accuracy. Symbology is software controlled with stadiometric or ballistic reticules available

The module subassemblies include:

- (a) a coaxial short wavelength tracker derived from the M2/3 Bradley system
- (b) a digital command guidance electronic system derived from the M2/3 Bradley unit
- (c) single field-of-view visual optics for target acquisition and tracking
- (d) a two field-of-view HIRE thermal sensor for target acquisition and tracking in degraded visibility and at night
- (e) full TOW-2A tracking and guidance software

SPECIFICATIONS

ELEVATION RANGE

-20° to +60°, mechanically coupled

BORESIGHT RANGE

6.5 mrad

visual and TOW

thermal sensor

Unity channel

FIELD-OF-VIEW

x 1 magnification

TOW and visual module

±10 mrad azimuth and elevation

12° × 8°

MAGNIFICATION

FIELD-OF-VIEW 7.5° (circular)

Short wavelength tracker

FIELD-OF-VIEW

narrow 0.5 wide

Thermal sensor, long wavelength tracker

MAGNIFICATION \times 12 and \times 4

FIELD-OF-VIEW

 $1.7^{\circ} \times 4.1^{\circ}$ narrow wide 5.2° × 12.3° WAVEBAND REGION

8-12 um DETECTOR 60-element HgCdTe

RETICULES NATO, stadiometric (programmable)

SYMBOLOGY range, ammunition, faults etc

(programmable)

DISPLAYS primary for gunner remote or commander

Status: Production as required.

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems,

PO Box 902, El Segundo, California 90425, USA.

Telepone: (310) 616 1022 Telex: 685504

Hughes Infra-red Equipment (HIRE) for Gunner's Periscope Sights

Development/Description

The modular Hughes Infra-red Equipment (HIRE) is a high performance thermal imaging system that can be integrated into the small turrets of Light Armoured Vehicles such as the LAV-25. One HIRE configuration is in production for the overseas sale of LAV-25 vehicles whilst a second is in production for the Spanish AMX-30 upgrade. Other configurations have been tested on M48A5, M60A3 and T-series MBTs.

The HIRE consists of three subassemblies:

- (a) sensor and gunner's display
- (b) commander's remote display
- (c) power supply/electronics unit.

Its modular design allows HIRE to replace the image intensifiers on most existing armoured fighting vehicles in order to significantly improve their operational capability at night. It also offers a choice of image displays and control: one or two displays, monocular and biocular eyepiece and multiplexed or standard TV output.

SPECIFICATIONS (Target Acquisition/Fire Control Configuration)

FIELD-OF-VIEW

narrow

wide

azimuth elevation 4.1° 1.7° 12.3° 5.1°

WAVEBAND REGION 8-12 μm

DETECTOR 60 element HgCdTe

IMAGE DISPLAY CR

RETICULES NATO, Stadiometric (and other

programmable)

SYMBOLOGY range, ammunition, fault etc (programmable)

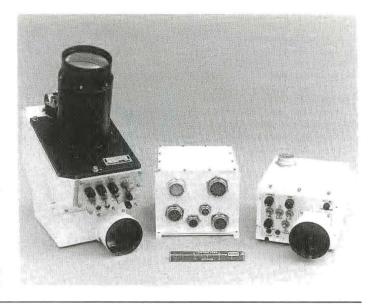
POWER SUPPLY vehicle system

Status: Production. In service with several countries.

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems, PO

Box 902, El Segundo, California 90425, USA. Telephone: (310) 616 1022 Telex: 685504

Hughes Infra-red Equipment (HIRE) as used on tank gunner's periscope



Hughes Armoured Gun System (AGS) Gunner's Primary Sight

Development/Description

Under a \$6.2 million production subcontract with prime AGS contractor FMC Corporation, Hughes Aircraft Corporation is to provide the AGS Gunner's Primary Sight (GPS). This is based on a company developed sight for the US Marine Corps LAV-105. The modular AGS GPS will allow a day or night and through smoke or dust 'shoot-on-the-move' capability using a unity window and a dual field-of-view × 3.3 and × 10 magnification hard optic TV camera day sight unit with Huges Infra-Red Equipment (HIRE) components. The AGS GPS has modularity features that allow for applications to other armoured vehicles, such as the M60 MBT. In the latter and other MBT cases a full solution fire control system can also be offered. The AGS GPS comprises the following sub-systems:

 (a) Hughes HIRE – with a 240 line common module based thermal imager, programmable reticles and symbology, and dual field-of-view capability (narrow 4.1 × 1.7°, wide 12.3 × 5.1°)

- (b) Line-of-Sight Stabilisation Platform (LOSP) based on the system as used in the South Korean K1 MBT and fitted with an armour housing for ballistic protection and two-axis gyro stabilised head mirror
- (c) Laser Rangefinder the same 1.064 μm Nd-YAG unit as produced for the M1 Abrams MBT
- (d) Commander's Remote Display (CRD) which remotely displays the day and night sight images and can be used to override all the gunner's controls
- (e) Gunner's Sight Electronics Unit (GSEU).

Status: Development. On order for the US Army AGS, first deliveries of vehicle are due in 1996.

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems, PO Box 902, El Segundo, California 90425, USA. Telephone: (310) 616 1022 Telex: 685504

Hughes Day/Night Gunner's Integrated Sight Unit (ISU)

Development/Description

The Hughes Day/Night thermal Integrated Sight Unit (ISU) was developed as part of the TOW Weapon Subsystem for use on the gunner's station of the M2/M3 Bradley IFV. It has magnifications of \times 4 and \times 12 with an optical relay for the vehicle commander.

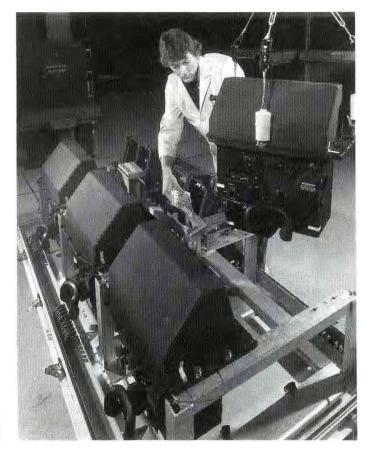
The sight enables the gunner to accurately aim and fire the turret's M242 25 mm cannon, 7.62 mm M240C machine gun and TOW family ATGWs.

Status: Production (over 7000 produced by early 1993). In service with Saudi Arabia and US Army (on the Bradley M2 IFV/M3 CFV). In October 1990 Hughes Aircraft Company was awarded a \$77.8 million contract for the first year of a multiyear procurement contract for 1398 TOW 2 Weapon Subsystems for the US Army. The Subsystem includes the ISU. Total value of the contract is estimated at around \$108 million with an option on another 710 Subsystems that is worth approximately \$52 million.

Manufacturers: Hughes Aircraft Company, Electro-Optical Systems, PO Box 902, El Segundo, California 90425, USA Telephone: (310) 616 1022 Telex: 685504

Texas Instruments Inc, Defence Systems and Electronics Group, PO Box 660246, Dallas, Texas 75266, USA

Telephone: (214) 480 6241 Telex: 4709900



Hughes Day/Night Integrated Sight Units for M2/M3 Bradley Fighting Vehicle System being loaded into a shipping container for despatch to FMC Corporation

Hughes Electro-Optical Tracking System (EOTS)

Development/Description

The Hughes developed Electro-Optical Tracking System (EOTS) is designed for air defence applications use on combat vehicles. It combines FLIR thermal imaging and near-IR TV sensors, and a high repetition rate Raman eyesafe laser rangefinder to track helicopters and high performance aircraft through darkness, smoke, haze and inclement weather. EOTS has been demonstrated to a number of foreign military customers. The sensors are integrated into a two-axis digital stabilised 360° field-of-regard panoramic sight that is equipped with a Dual Mode Tracker. The latter is fitted with a correlation/centroid video tracker system that allows the EOTS to maintain a track on aircraft flying through clutter such as hills or trees. A Digital Scan Converter (DSC) is fitted for TV compatible output video.

SPECIFICATIONS

ELEVATION RANGE AZIMUTH RANGE LINE-OF-SIGHT STABILISATION VIDEO OUT SYMBOLOGY, RETICLES AND DATA DISPLAY Thermal sensor

WAVEBAND REGION **DETECTOR TYPE**

MAGNIFICATION narrow wide FIELDS-OF-VIEW

narrow wide

Laser rangefinder LASER TYPE

WAVELENGTH REP RATE RANGE TV sensor

WAVEBAND REGION FIELDS OF VIEW

narrow wide IRIS TYPE SENSITIVITY -10 to +75° 360° ≤50 microrads

NTSC (RS170) programmable

8-12 um

1st generation, (PC, HgCdTe 120 element)

 \times 10 $\times 3.3$

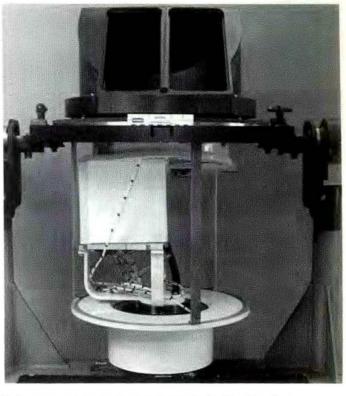
 $2.5 \times 3.3^{\circ}$ $7.5 \times 10^{\circ}$

Raman shifted Nd-YAG

1.54 µm SS, 15 Hz 200 to 20 000 m

0.4 to 1.1 µm

 $2.5 \times 3.3^{\circ}$ $7.5 \times 10^{\circ}$ auto/manual CCD 0.5 lux



Sight sensor unit for the Hughes Electro-Optical Tracking System

Tracker DUAL MODE SWITCHING ACQUISITION

auto/manual auto/manual COAST auto/forced

Status: Ready for production.

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems, PO Box 902, El Segundo, California 90425, USA. Telephone: (310) 616 1022 Telex: 685504

Hughes Second Generation Tank Sight (SGTS)

Development/Description

In March 1992 the US Army Night Vision & Electro-Optics Directorate selected Hughes Aircraft Company to demonstrate second generation FLIR technology in a multi-sensor tank sight testbed for US Army evaluation and future incorporation into advanced combat vehicles.

The SGTS prototype will be delivered in 1993 for integration into the US Army's Component Advanced Technology Test Bed field trials.

The SGTS is a 360° field-of-regard panoramic sight and will consist of a second generation thermal imaging sensor, a Charge Coupled Device (CCD) TV camera and an eyesafe laser rangefinder. Based on existing Hughes components, the sight will also have provision for future insertion of automatic target tracking and recognition capability. Extensive Built-in Test facilities are also fitted.

The prototype is being used to demonstrate advanced technologies such

- (a) high density infra-red detector arrays (PV, HgCdTe type with 480 x 4 elements)
- (b) high image processing
- (c) eyesafe laser ranging
- (d) precision two-axis stabilisation.

The technologies are derived from several development programmes already underway. They include:

- (a) The US Army's Standardised Advanced Dewar Assembly (SADA) programme to establish initial production pilot lines for second generation detector assemblies, coupled with the DARPA-funded Infra-red Focal Plane Array (IRFPA) programme
- (b) The Hughes Electro-Optical Tracking System (EOTS) which combines thermal imaging and TV sensors, and a high repetition rate Raman eyesafe laser rangefinder to track aircraft and helicopters (qv EOTS entry)

(c) The Hughes Raman eyesafe laser rangefinder which is in development for the M1 Abrams MBT family.

SPECIFICATIONS

ELEVATION RANGE AZIMUTH RANGE LINE-OF-SIGHT STABILISATION VIDEO OUT SYMBOLOGY, RETICLE AND DATA DISPLAY

Thermal sensor WAVEBAND REGION

DETECTOR TYPE MAGNIFICATION narrow

wide FIELDS-OF-VIEW

narrow

wide

Laser rangefinder LASER TYPE

WAVELENGTH REPETITION RATE RANGE

TV sensor WAVEBAND REGION FIELDS-OF-VIEW

narrow wide IRIS TYPE SENSITIVITY -12 to +22° 360°

<50 microrads

NTSC (RS170), plus digital out

simultaneous centroid/correlation

programmable

8-12 µm

2nd generation, SADA

 $\times 8.65$ $\times 2.9$ $2.5 \times 3.3^{\circ}$

 $7.5 \times 10^{\circ}$

Raman shifted Nd-YAG

1.54 µm 1 Hz 200 to 10 000 m

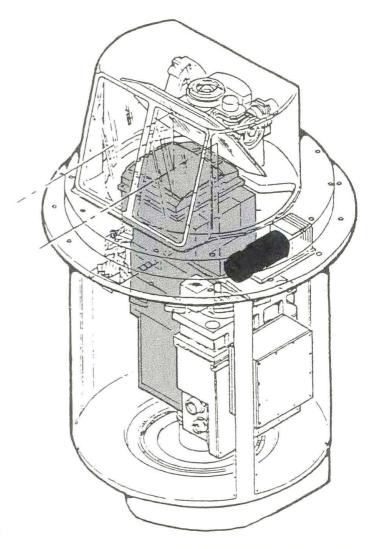
0.4 to 1.1 µm

2.5 × 3.3° 7.5 × 10° auto/manual CCD 0.5 lux

Status: Technology demonstrator. Prototype built for US Army

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems,

PO Box 902, El Segundo, California 90425, USA. Telephone: (310) 616 1022 Telex: 685504



Hughes Second Generation Tank Sight

Hughes M1 Abrams Thermal Imaging System (TIS)

Development/Description

The Thermal Imaging System (TIS) was developed by Hughes for use on the M1 Abrams MBT family under armour and produces an image by sensing the small difference in heat radiated by objects in view. The detected energy is converted into electronic signals which are displayed on a CRT tube, similar to a TV picture, and the image displayed is projected into the eyepiece of the gunner's sight.

In addition, the sight displays target range information from the Hughes laser rangefinder module and indicates the existence of more than one target.

Ready-to-fire indication, fire control computer symbology and system operational status data are also provided.

The TIS itself generates a graticule pattern boresighted to the day sight graticule and laser rangefinder. This allows the gunner to operate the sight just as he would the day sight and engage targets up to 2400 m away with a high first round hit probability.

If required, the TIS can be repackaged for use in lighter armoured vehicles where multiple or remote displays can be utilised.

Status: Production (over 9500 built by January 1993). In service with the US Army (on M1/M1A1 Abrams MBTs).

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems, PO Box 902, El Segundo, California 90425, USA. Telephone: (310) 616 1022 Telex: 685504

Technician adjusting Hughes Thermal Imaging System installed in M1/M1A1 Abrams MBT

Hughes M1A2 Gunner's Primary Sight Line-of-Sight Subsystem (GPS-LOS)

Development/Description

Under a \$24 million production subcontract with General Dynamics, Hughes will deliver 402 of its GPS-LOS for the US Army (62 plus spares) and Saudia Arabia (the balance of the order). Deliveries are due to be completed in Spring 1994. Under previous contracts Hughes delivered 24 prototype and 17 pilot production systems for the development programme.

The GPS-LOS subsystem is a two-axis stabilised head mirror that significantly improves the first round hit probability. Current M1 and M1A1 versions of the Albrams tank are equipped with a single axis stabilised head mirror. The two axis system on the M1A2 enables faster target acquisition, improved gun pointing, and because the azimuth axis is inertially stabilised, the gunner can detect, recognise and acquire additional targets at greater ranges. A built-in test facility is controlled by microprocessor to provide an intelligent test and isolation capability.

PERFORMANCE

LOS EXCURSION RANGE

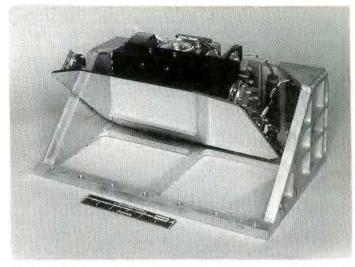
BORESIGHT RETENTION

elevation -16 to +22°

azimuth +50

STABILISATION ACCURACY ≤100 microradians PLUMB AND SYNCHRONISATION ≤70 microradians

Status: Production. In service with US Army and Saudi Arabia.



Hughes M1A2 Gunner's Primary Sight Line-of-Sight Subsystem (HPS-LOS)

Manufacturer: Hughes Aircraft Company, Electro-Optical Systems,

PO Box 902, El Segundo, California 90425, USA. Telephone: (310) 616 1022 Telex: 685504

Kollsman Day/Night Range Sight (DNRS)

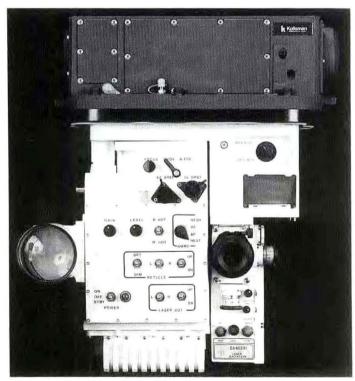
Development/Description

The modular DNRS system was developed as a low cost private venture sight for installation in tanks such as the M41, T-54/55/59, M48 and M60 and US Marine Corps light armoured vehicles such as the AAV7A1, LAV-25 and proposed LAV-105.

≤100 microradians

The DNRS is designed to increase the first round hit probability, reduce the gunner's reaction time from initial target detection to firing and improve overall sight reliability and maintainability under adverse combat and environmental conditions.

It can interface with either a mechanical drive, electronic drive or stabilised head mirror and provides for 16-bit Binary Coded Decimal (BCD) format for interfacing to either a fire control computer or Kollsman designed ballistic processor



Kollsman Day/Night Range Sight from operator's side

The main elements of the DNRS system are:

- (a) gunner's primary sight with unity-magnification window channel interface to the sight periscope head assembly, a Nd-YAG laser integrated periscope and an electro-optical countermeasures hardened thermal channel with a 60 element common module CMT detector and a digital scan converter to generate RS170 TV signals
- (b) commander's remote display
- (c) power conditioning unit

Available options for the system include the following:

- (a) daylight periscope
- (b) image intensifier sight
- (c) electronically stabilised 2-axis periscope heads
- (d) commander's remote-control unit
- (e) commander's remote day and/or thermal displays
- (f) ballistic computer system
- (g) 625 lines CCIR video format
- (h) gunnery training system
- ballistic/nonballistic reticles
- eye-safe laser training filters
- (k) AN/VSG-5 laser integration

Available system growth potential includes the use of a 240 x fourchannel CMT Focal Plane Array (FPA) thermal imaging detector developed by SOFRADIR of France to improve operational range and resolution performance by using twice the signal/noise ratio of the existing built-in equipment.

SPECIFICATIONS

ELEVATION RANGE -20° to +60° WEIGHT 79.55 kg Surveillance window MAGNIFICATION Laser Integrated Periscope MAGNIFICATION × 8 FIELD-OF-VIEW Nd-YAG WAVELENGTH 1.06 µm **OPERATING RANGE** 200-9990 m ACCURACY

Thermal Channel (Uses TOW SU-108 Series Basic Sight Assembly)

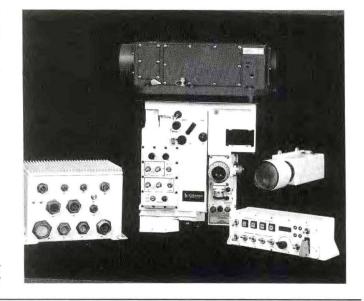
+5 m

WAVEBAND REGION 8-12 um 60, parallel scan **ELEMENTS** VIDEO FORMAT RS-170, 525 lines FIELD-OF-VIEW

× 2.8 magnification $3.4 \times 6.8^{\circ}$, wide × 8.4 magnification 1.1 × 2.2°, narrow Status: Production as required. It has been fitted on two of the three shortlisted vehicles being trialled to meet the requirements of the Norwegian Army LAV programme (the SANTA BARBARA/Steyr-Daimler-Puch ASOD and the Hägglunds Vehicle Combat Vehicle 9030).

Manufacturer: Kollsman Division of Sequa Corporation, 220 Daniel Webster Highway, Merrimack, New Hampshire 03054-4809, USA.

Telephone: (603) 889-2500 Telex: 943537 Fax: (603) 889 7966



Kollsman Day/Night Range Sight from left to right: sight interface power conditioner, DNRS, computer control panel and commander's display

Kollmorgen Model 220 Fire Control Sight

Development/Description

The Model 220 is a modular day/night monocular eyepiece periscope that is equipped with a Laser Rangefinder (LRF) module and unity vision periscope to provide fire control capabilities. Applications include the M41 light tank and M47, M48 and MB-3 Tamoyo MBTs.

Apart from the Nd-YAG laser coaxial transceiver module the sight modules include the main assembly body, the sight head and the sight control panel. An additional support unit is the Commander's Control and Display Unit

The sight head module contains a 2:1 motion reduction transmission which links the gun elevation position arm to the sight's upper deviator mirror. The sight control panel provides the gunner with brightness controls and first/last pulse laser logic select.

The main body features the unity acquisition periscope, an eyepiece viewed range display and a CRT to provide the gunner with a computer controlled aiming mark. Day/night sight selection is made by switching a single actuating lever. For night vision a 25 mm inverter second-generation image intensifier tube assembly is used.

The CCDU contains the LRF electronics module, a prime power filter, commander's range display, a laser safety key switch and the main power switch.

SPECIFICATIONS

ELEVATION RANGE -18° to +22° Day channel

MAGNIFICATION $\times 8$ FIELD-OF-VIEW

PARALLAX BETWEEN IMAGE OF INFINITE TARGET, RETICULE

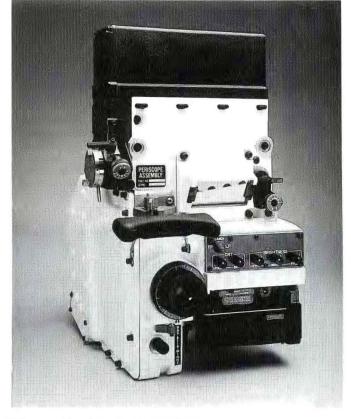
AND CRT 0.15 mils max BORESIGHT ADJUSTMENT RANGE ±8 mils

Unity periscope MAGNIFICATION $\times 1$ FIELD-OF-VIEW 8.5 elevation azimuth 18

Night channel MAGNIFICATION × 8 FIELD-OF-VIEW

IMAGE INTENSIFIER TUBE 25 mm GEN II inverter

Status: Limited production.



Kollmorgen Model 220 Fire Control Sight

Manufacturer: Kollmorgen Corporation, Electro-Optical Division, 347 King Street, Northampton, Massachusetts 0160, USA.

±1 mrad of day channel

Telephone: (413) 586 2330 Telex: 955409 Fax: (413) 586 1324

Kollmorgen Model 317 Night Vision Kit for M20 Sight

Development/Description

The Model 317 night vision kit incorporates a night vision channel unit into a standard M20 periscope sight to provide a day/night operational capability. Applications include the commander's and gunner's M20 sights of the M41 light tank and the M47/M48 MBTs.

The night vision channel kit includes an objective lens, a second-generation (GEN II) image intensifier tube assembly, relay lenses, a day/night mirror assembly and a power supply unit. In addition, it can be installed with or without a 1:1 vision block prism.

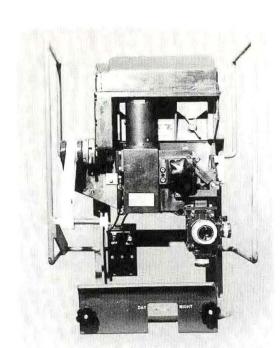
SPECIFICATIONS Night channel

MAGNIFICATION $\times 6$ FIELD-OF-VIEW 80 **APERTURE** 45 mm FOCAL LENGTH 180 mm

BORESIGHT ACCURACY (including parallax error)

Day channel

MAGNIFICATION × 6 FIELD-OF-VIEW **APERTURE** 30 mm



Status: Pre-production.

Manufacturer: Kollmorgen Corporation, Electro-Optical Division, 347 King

Street, Northampton, Massachusetts 01060, USA.

Telephone: (413) 586 2330 Telex: 955409 Fax: (413) 586 1324

Kollmorgen Model 317 Night Vision Kit for M20 Sight

Kollmorgen Model 910 Integrated Sight

Development/Description

The Model 910 integrated sight is a small stabilised system designed for installation on the turret of tracked armoured vehicles. It provides a reconnaissance capability or an accurate weapon positioning and turret control capability to the gunner of the vehicle. Applications include the XM42 and the ZSU-23-4 simulator.

The sight provides dual axis gyrostabilised viewing and can be either a master or a slave unit to the other subsystems aboard the vehicle.

SPECIFICATIONS

ELEVATION RANGE -10° to +85° FIELD-OF-VIEW

× 2 magnification × 8 magnification

OUTPUT SIGNALS 2 speed resolver with 1 mrad accuracy for

elevation

SLAVE MODE line-of-sight controlled by external synchro

signal TRACKING ACCURACY ±1 mrad

SLEWING RATE

100°/s azimuth

elevation 100°/s

Status: Low rate production.

Manufacturer: Kollmorgen Corporation, Electro-Optical Division, 346 King

Street, Northampton, Massachusetts 01060, USA.

Telephone: (413) 586 2330 Telex: 955409 Fax: (413) 586 1324



Kollmorgen Model 910 Integrated Sight

Kollmorgen Model 957 Squad Leader's Search Periscope

Development/Description

The Model 957 is an optical periscope designed specifically to provide the squad leader of an APC or similar type vehicle with a search and surveillance capability whilst remaining within the protection of the vehicle. Applications of the Model 957 are the Improved TOW Vehicle (ITV), the Light Armored Vehicle (LAV), the Fire Support Team Vehicle (FISTV) and the Elevated Kinetic Energy Test Demonstration Vehicle (ELKE).

It is a sealed single magnification optical device that is used as a target acquisition and vehicle protective surveillance device with viewing and control functions internal to the vehicle. The periscope is of the rotational fixed position sight type.

SPECIFICATIONS

WEIGHT 27.2 kg (max) **ELEVATION RANGE** -20° to +10° TRAVERSE 360° MAGNIFICATION \times 4 (min) FIELD-OF-VIEW 12.5° (min) EYEPIECE FOCUS ±4 diopters (min)



Status: Production. In service with the US army and other undisclosed countries.

Manufacturer: Kollmorgen Corporation, Electro-Optical Division, 347 King

Street, Northampton, Massachusetts 01060, USA.

Telephone: (413) 586 2330 Telex: 955409 Fax: (413) 586 1324

Kollmorgen Model 957 Squad Leader's Search Periscope

Kollmorgen Model 938 Commander's Weapon Station Sight

Development/Description

The Model 938 monocular daylight periscope was designed as a sighting device for the commander's weapon station on the M1/M1A1 Abrams MBT. It is mounted near and mechanically linked to the gun and has a graticule

pattern presented in the field-of-view. An integral laser filter is provided to protect the commander's eyes from laser energy.

SPECIFICATIONS

WEIGHT 8.2 kg **ELEVATION RANGE** -10° to +65° MAGNIFICATION FIELD-OF-VIEW

Status: Production. In service with the US armed forces (on M1/M1A1 MBTs).

Manufacturer: Kollmorgen Corporation, Electro-Optical Division, 347 King Street, Northampton, Massachusetts 01060, USA.

Telephone: (413) 586 2330 Telex: 955409 Fax: (413) 586 1324



Kollmorgen Model 938 Commander's Weapon Station Sight as used on M1/M1A1 MBT

Kollmorgen Model 939 Gunner's Auxiliary Sight

Development/Description

The Model 939 auxiliary periscope was designed as a primary or backup sight for an MBT gunner. It is mounted coaxially with the main gun and is articulated to minimise eyepiece movement when the armament is elevated or depressed

A diopter adjustment is provided to accommodate focal variations between individual observers. Individual graticule patterns may be presented in the field-of-view according to the mission requirements. An integral laser filter is used to protect the gunner's eyes from laser energy and a switchable filter is fitted to permit use during high brightness conditions.

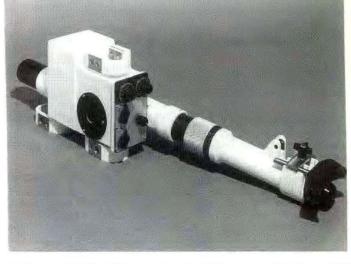
SPECIFICATIONS

16.8 kg WEIGHT MAGNIFICATION ×8 FIELD-OF-VIEW 80

Status: Production. In service with the US (on M1/M1A1 MBTs) and South Korean (on Type 88 MBTs) armed forces.

Manufacturer: Kollmorgen Corporation, Electro-Optical Division, 347 King Street, Northampton, Massachusetts 01060, USA.

Telephone: (413) 586 2330 Telex: 955409 Fax: (413) 586 1324



Kollmorgen Model 939 Gunner's Auxiliary Sight used on M1 Abrams MBT

Kollmorgen Model 998 Fire Control Backup Sight

Development/Description

The Model 998 was developed for use as a backup fire control sight for aiming and firing the M242 25 mm cannon of the electrically stabilised turret mounted on the FMC M2/M3 Bradley series fighting vehicles.

It is mechanically linked to the cannon and allows either the gunner or the vehicle commander to use the weapon. It is also fitted with an armoured head and an eye protection system for the observer from laser energy

SPECIFICATIONS

WEIGHT 22.6 kg **ELEVATION RANGE** -11° to +61° MAGNIFICATION $\times 5$ FIELD-OF-VIEW 10

Status: Production. In service with Saudi Arabia and US Army (on the M2 Bradley CFV and M3 Bradley IFV).

Manufacturer: Kollmorgen Corporation, Electro-Optical Division, 347 King Street, Northampton, Massachusetts 01060, USA.

Telephone: (413) 586 2330 Telex: 955409 Fax: (413) 586 1324

Kollmorgen Model 998 Fire Control Backup Sight used on M2/M3 Bradley Fighting Vehicle Family

Miller-Holzwarth Armoured Vehicle Periscopes

Development/Description

Miller-Holzwarth, a division of Baird Corporation, produces a wide range of standard US armoured vehicle optical day vision periscopes for both the US armed forces and foreign users.

The range available includes:

- (a) NATO standard M17 periscope
- (b) NATO standard M27 periscope
- (c) NATO standard M37 periscope
- (d) NATO standard M45 periscope
- (e) NATO standard Leopard and wheeled Armoured Vehicle General-Purpose (AVGP) periscope
- (f) South Korea Type 88 periscope
- (g) AAV7A1 US Marine Corps special periscope
- (h) M2/3 Bradley family periscope with blackout blind with OIP filters
- (i) M1 short driver's periscope with OIP filters
- (j) M1 short commander's periscope with OIP filters
- (k) M1 tall commander's periscope with OIP filters

Most of the periscope models can be supplied with blackout blinds (if

- (I) M1 long driver's periscope, with OIP filter
- (m) vision block, FIST-V, with OIP filters
- (n) LAV periscope and vision blocks, with OIP filters
- (o) ICWS periscope, with OIP filters
- (p) ballistic windows for HMMWV and armoured vehicles.



M17 periscope

Status: Production as required. In service with the US armed forces and numerous other countries (on M1, M2, M3, Type 88, and other armoured vehicles).

Manufacturer: IMO Industries Inc., Miller-Holzwarth Division, 166 S Ellsworth, Salem, Ohio 44460, USA. Telephone: (216) 337 8376 Fax: (216) 337 9478

Optic-Electronic M32E1 Tank Gunner's Periscope

Development/Description

The M32E1 is a standard US armed forces tank gunner's periscope and is installed on the M48A3, M48A5, M60 and M60A1 MBTs. It can also be adapted for installation on other tank models.

It comprises the following subsystems:

(a) head assembly which consists of a cast housing and contains an entrance window, a mirror attached to an elevation drive mechanism and a unity-magnification vision channel with the infinity sight graticule projected for sighting the main armament coaxial machine gun.

An M118 mount is required to install the head assembly in the tank and a ballistic drive of the M10 type is required for input to the elevation mechanism

- (b) daylight optics elbow assembly which fits into the head assembly and contains an objective lens, graticule unit and a prism unit. The graticule is adjustable for accurate boresighting of the weapon by use of elevation and azimuth boresight adjustment knobs. The diopter setting of the monocular eyepiece is fully variable and the graticule can be illuminated by a small incandescent lamp at night
- (c) standard US Army passive night vision elbow which fits into the head assembly and contains a second-generation passive night vision 25 mm image intensifier tube to amplify the night time illumination such as sky glow, starlight and moonlight to provide an undetectable night fighting capability for the tank.

SPECIFICATIONS

WEIGHT 23.6 kg

DIMENSIONS $500 \times 350 \times 330 \text{ mm}$

ELEVATION RANGE -17° to +22°

Unity vision channel

MAGNIFICATION × 1 FIELD-OF-VIEW

horizontal 30.5

vertical 5.8°

Daylight optics module

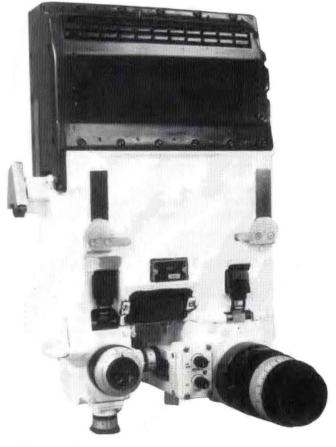
 MAGNIFICATION
 × 8

 FIELD-OF-VIEW
 8°

 Passive night vision channel
 MAGNIFICATION
 × 7.

 FIELD-OF-VIEW
 7.2°

POWER SUPPLY 18-30 V DC vehicle system



Optic-Electronic Standard US Army M32E1 Gunner's Periscope Sight

Status: Production as required. In service with numerous countries.

Manufacturer: Optic-Electronic Corporation, 11545 Pagemill Road, Dallas,

Texas 75243, USA

Telephone: (214) 349 0190 Telex: 910 8619 312 Fax: (214) 343 7259

Optic-Electronic M35E1 Tank Gunner's Periscope

Development/Description

The M35E1 is the standard US armed forces tank gunner's periscope installed on the M60A3 MBT. It can also be adapted for installation on other tank models.

It comprises the following subsystems:-

(a) head assembly which consists of a cast housing and contains an entrance mirror, a mirror attached to an elevation drive mechanism and the unity-magnification vision channel with beam splitter for graticule projection for sighting the main armament's coaxial machine gun.

An M118E1 mount is required for installation of the head assembly in the tank and a ballistic drive of the M10 type is required for input to the elevation mechanism

- (b) daylight optics elbow which fits into the head assembly and contains an objective lens, graticule imaging lens, prism beam splitter assembly and neutral, red, amber and clear filters
- (c) standard US Army passive night vision elbow which fits into the head assembly and contains a second-generation passive night vision 25 mm image intensifier tube to amplify the night time illumination such as sky glow, starlight and moonlight to provide an undetectable night fighting capability for the tank.



SPECIFICATIONS

WEIGHT 23.6 kg

DIMENSIONS $500\times350\times330~\text{mm}$ **ELEVATION RANGE** -18° to +22°

Unity vision channel

MAGNIFICATION

FIELD-OF-VIEW horizontal 30.5 vertical 5.8

Daylight optics module

MAGNIFICATION ×8 FIFI D-OF-VIEW Passive night vision channel MAGNIFICATION × 7.1°

FIELD-OF-VIEW 7.20

POWER SUPPLY 18-30 V DC vehicle system

Status: Production. In service with numerous countries.

Manufacturer: Optic-Electronic Corporation, 11545 Pagemill Road, Dallas,

Texas 75243, USA.

Telephone: (214) 8619 312 Telex: 910 8619 312

Fax: (214) 343 7529

Optic-Electronic M36E1 Day/Night Tank Periscope

Development/Description

The standard US army monocular M36E1 day/night sight is designed for use on the following vehicles:

Vehicle type	Gunner	Commander
V-150	yes	
LAV-25	yes	yes
Stingray light tank	M36-SIRE	-
M48/60 MBT	_	yes
AAV7	yes	_

It consists of three separate and independently collimated units:

- (a) head assembly which is a precision cast aluminium housing with two covers and contains a prism attached to an elevation drive mechanism, a mounting plate assembly, an entrance window and an observer's window. It acts as the input source for both the daylight and image intensification systems of the periscope
- (b) body assembly which consists of a one piece machine cast body housing and the daylight body assembly.

The housing contains an entrance window, a unity-magnification mirror and an exit window. The mirror, hermetically sealed between the entrance and exit windows and eyepiece assemblies, is mounted so that the operator can rapidly change his line-of-sight between the various eyepieces. The daylight body assembly contains an objective lens, a prism assembly, an etched machine gun graticule positioned between the elevation and deflection boresight knobs and an eyepiece unit

(c) passive night vision elbow assembly which is fitted into the body assembly and is used for sighting during night engagements. A second-generation 25 mm image intensifier tube is used to amplify the natural night time illumination.

SPECIFICATIONS

WEIGHTS 11.45 kg head assembly body assembly 5 kg passive night vision elbow 8.18 kg

320.6 × 342.9 × 479.4 mm DIMENSIONS

ELEVATION RANGE -20° to +60°

Unity vision channel MAGNIFICATION Daylight vision body MAGNIFICATION × 7 FIELD-OF-VIEW 10 Passive night vision elbow MAGNIFICATION FIELD-OF-VIEW

POWER SUPPLY 18-30 V DC vehicle system



Optic-Electronic M36E1 Tank Periscope for M60 series MBTs and light armoured fighting vehicles

Status: Production as required. In service with numerous countries.

Manufacturer: Optic-Electronic Corporation, 11545 Pagemill Road, Dallas,

Texas 75243, USA.

Telephone: (214) 349 0190 Telex: 910 861 9312

Optic-Electronic M105 Series Gunner's Articulated Sighting Telescopes

Description

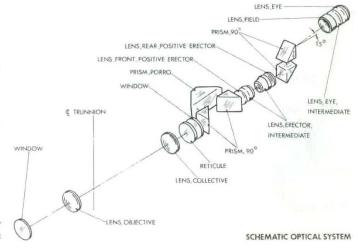
The articulated M105 series gunner's direct fire control telescopes are designed to be utilised as secondary sighting devices on M-series MBTs.

The three versions available are: the M105 for the 90 mm gun equipped M48A3; the M105C for the 105 mm gun equipped M60 and M60A1; and the M105D for the 105 mm gun equipped M48A5 and M60A1

All three are identical except for the graticules which are graduated for use with particular ammunition.

The basic sub-units are:

- (a) objective tube and graticule assembly
- (b) articulated joint assembly including the erector unit
- (c) offset prism assembly
- (d) evepiece assembly.



Schematic of M105 Series Gunner's Articulated Sighting Telescopes for M-series MBTs SPECIFICATIONS

WEIGHT DIMENSIONS 24.29 kg

length 1183.6 mm width 177.8 mm

RANGE OF TRAVEL ELEVATION

-11° to +22° of horizontal boresight position

MAGNIFICATION ×

FIELD-OF-VIEW 7.5° DIOPTER RANGE -4 to +4

Status: Production as required. In service with numerous countries.

Manufacturer: Optic-Electronic Corporation, 11545 Pagemill Road, Dallas,

Texas 75243, USA.

Telephone: (214) 349 0190 Telex: 910 861 9312

Optic-Electronic US Army Standard Passive Night Vision Elbow

Development/Description

The US Army standard passive night vision elbow was designed for use with the MP86 multi-purpose gunner's, GNP-55 gunner's, M32E1 gunner's, M35E1 gunner's and M36E1 commander's sight systems as the replacement for the original infra-red elbow.

It uses a 25 mm second-generation image intensifier tube with 28 LP/mil to amplify night time illumination such as moonlight, starlight and sky glow. A muzzle flash protection circuit is also fitted.

If required by the customer the standard eyepiece can be replaced at the factory by either a beamsplitter type for use with a TV video camera or optical relay device or a bi-ocular type for improved observation.

SPECIFICATIONS

WEIGHT 8.17 kg

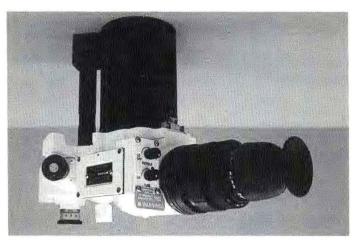
DIMENSIONS 280 × 160 × 350 mm

MAGNIFICATION × 7.1 FIELD-OF-VIEW 7.2°

FOCAL RANGE 50 m to infinity

RETICLE ILLUMINATION 2.5 V DC incandescent lamp

Status: Production. In service with the US armed forces and many other countries worldwide.



Passive night vision elbow for use on a wide range of commander's and gunner's sights

Manufacturer: Optic-Electronic Corporation, 11545 Pagemill Road, Dallas,

Texas 754243, USA. Telephone: (214) 349 0190

Telex: 910 861 9312

Fax: (214) 343 7529

Optic-Electronic GNP 55 Gunner's Night Vision Periscope

Development/Description

The GNP 55 gunner's night vision periscope is designed for direct fire control use on T-54 and Type 59 series MBTs. It consists of a head assembly (with a closed loop, balanced, band driven mirror), a unity body and either a passive image intensifier night vision elbow or a thermal viewer unit option.

The passive night vision elbow is a variant of the standard US Army elbow found in the M32/M35/M36 series of sights with the necessary modifications required for use with a T-series tank fire control system. It uses a high resolution second-generation image intensifier tube assembly which amplifies the natural night-time illumination such as moonlight, starlight and sky glow.

The tube has a muzzle flash protection feature that permits the gunner to observe and correct the impact of kinetic and explosive projectiles without disrupting his night vision capability. Rechargeable batteries and a bayonet electrical fitting are incorporated into the elbow design.

If the thermal viewer option is used then the system chosen needs to have the same physical mounting dimensions as the standard US Army night vision elbow.

The periscope itself is powered by the 24 V DC vehicle power supply system but has rechargeable NiCad batteries for use when the vehicle power is off for any reason.

SPECIFICATIONS (GNP 55 passive night vision elbow option)

WEIGHT less than 22.7 kg

MAGNIFICATION × 7.1 FIELD-OF-VIEW 120 mils

 RESOLUTION
 0.21 mil at 3 × 10⁻³ Ft-1

 FOCUS
 50 m to infinity

 GAIN
 1000 (min)

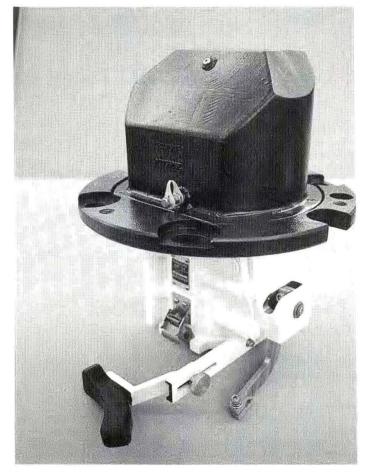
 OBJECTIVE
 198 mm, f/2

 POWER SUPPLY
 18-30 V DC

Status: Production as required.

Manufacturer: Optic-Electronic Corporation, 11545 Pagemill Rd, Dallas,

Texas 75243, USA. Telephone: (214) 349 0190 Telex: 910 8619 312 Fax: (214) 343 7259



Optic-Electronic GNP 55 gunner's night vision periscope which can be configured with OEC standard US Army passive night vision elbow or thermal elbow

Optic-Electronic NV46S Commander's Passive Night Vision Periscope

Development/Description

The NV46S periscope is designed to give the commander of a T-54/55/62 or Type 59 MBT a passive night vision capability under sky glow, starlight, or moonlight without recourse to artificial illumination.

It uses an 18 mm, second-generation, wafer type, image intensifier tube which is fitted with a muzzle flash response unit that allows the commander to observe the impact of both kinetic and high explosive shells without disrupting his night vision capability. A stadia and mil scale reticle is also mounted on the image intensifier.

A series of simple switches which includes a snap action shutter/switch, a brightness adjuster knob, focus ring, diopter adjustment ring and dual thumb switches for searchlight/turret operation are fitted.

The NV46S attaches to the searchlight control arm in the same manner as the TKN-1C infra-red sight and provides the necessary elevation control if the searchlight is needed.

Power is normally obtained from the vehicle's 24 V DC supply with two GE KOIAIIICs GT3 rechargeable batteries as backup if the power fails for any reason.

SPECIFICATIONS

WEIGHT 4.6 kg

DIMENSIONS $270\times180\times340~mm$

MAGNIFICATION × 4.4 FIELD-OF-VIEW 80

RESOLUTION (contrast=1) at 10-3Ft-L 0.30 mil at 10-6Ft-L 0.90 mil FOCUS RANGE 10 m to infinity 1000 (min) GAIN DIOPTER RANGE -5 to +4 **OBJECTIVE** 128 mm, f/2

Status: Production as required.



Optic-Electronic NV46S commander's passive night vision periscope from rear

Manufacturer: Optic-Electronic Corporation, 11545 Pagemill Road, Dallas. Texas 75243, USA

Telephone: (214) 349 0190 Telex: 910 8619 312 Fax: (214) 343 7259

Optic-Electronic NV52 Day/Night Vision Periscope

Development/Description

The NV52 dual channel monocular type optical sight is designed for use by crews of light armoured vehicles in fire control and day/night observation situations.

It uses a modified M32 day body assembly with a standard night vision elbow of improved reliability. The latter has a 25 mm second-generation image intensifier tube with a customer specified ballistic graticule.

SPECIFICATIONS

ELEVATION BANGE -16° to +23°

Daylight sight FIELD-OF-VIEW 80

Night vision elbow

MAGNIFICATION FIELD-OF-VIEW 7.20

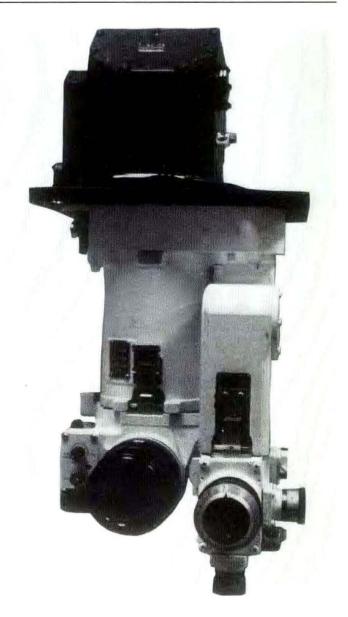
POWER SUPPLY 18-24 V DC vehicle system

Status: Production. In service with Thailand (Stingray light tank as NV52C).

Manufacturer: Optic-Electronic Corporation, 11545 Pagemill Road, Dallas,

Texas 75243, USA.

Telephone: (214) 349 0190 Telex: 910 8619 312 Fax: (214) 343 7259



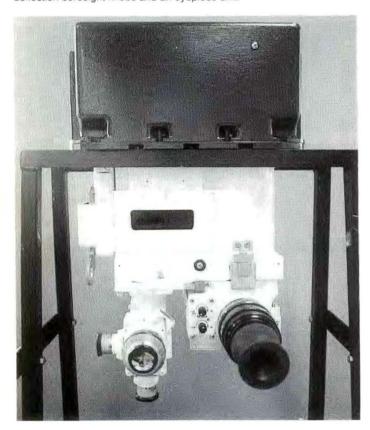
Optic-Electronic MP86 Multi-purpose Gunner's Periscope

Development/Description

The MP86 gunner's modular sight system head may be configured to meet a variety of customer light armoured fighting vehicle requirements (for example AIFV) including the fitting of either left- or right-hand drives. It is designed as a direct upgrade replacement for the M36E1 sight and can also be used to replace M32E1 and M35E1 systems. It can be installed into a turret roof without the need for separate M119E1 or M118E1 mounting brackets required by the M-series periscopes.

Dual entrance and exit windows, angled to reduce narcissus, are readily interchanged to permit operation with either a daylight sight or laser rangefinder plus a Forward Looking Infra-Red (FLIR) or image intensifier night vision sight. The increased aperture over standard M32/M35 and M36 heads allows a significant improvement in sight performance.

The daylight body assembly contains an objective lens, a prism assembly, an etched machine gun reticle positioned between the elevation and deflection boresight knobs and an eyepiece unit.



MP86 multi-purpose gunner's periscopes with daylight and night vision (image intensification) options

When configured for use with a second-generation 24 mm image intensifier night vision elbow the elevation assembly incorporates a prism for improved light gathering capability over a wide range of sight elevation angles.

If configured for FLIR use, the prism is replaced with a mirror. The glass windows on the infra-red side are also replaced with germanium windows whilst those on the daylight vision side remain the same.

The laser rangefinder integrated day sight body assembly contains a \times 7 magnification optical system and a laser protected unity-magnification vision channel. Boresighting and zeroing to a shot group is carried out by performing a simple adjustment to the laser line-of-sight. The laser aim mark is permanently aligned with the boresight mark.

The Q-switch Erbium-glass eyesafe laser can be equipped with a remote commander's display and is powered by the vehicle's own 24 V DC supply. For emergency backup external NiCad rechargeable batteries cut-in if the main supply fails for any reason.

If required, the laser rangefinder can be integrated with a fire control system.

Sight tracking accuracy is ensured by the balancing of the mirror (or prism assembly) and the use of either the left- or right-hand, thermally compensated, closed loop, steel band driving arrangement.

SPECIFICATIONS

ELEVATION/DEPRESSION +60°/-20°
POWER SUPPLY 24 V DC

Daylight sight option

MAGNIFICATION × 7
FIELD-OF-VIEW 10°

Laser rangefinder integrated daylight sight option

Laser transmitter

LASER TYPE Erbium-glass Q-switch, eyesafe

OUTPUT ENERGY nominal 10 MJ

BEAM WIDTH 1.0 rad (90% energy)

Optical channel

MAGNIFICATION × 7
EFFECTIVE APERTURE 50 mm

EYEPIECE adjustable focus

Laser receiver

 FIELD-OF-VIEW
 1.5 mrad

 EFFECTIVE APERTURE
 50 mm

 OPERATING RANGE
 200-10 000 m

 RANGE ACCURACY
 ±10 m

 DISCRIMINATION
 50 m

 RANGE LOGIC
 first/last pulse

 DISPLAY
 4 digit LED

Passive night vision elbow option
MAGNIFICATION × 7.1
FIELD-OF-VIEW 7.2°

Status: Production. In service with Turkish Army (on Armored Infantry Fighting Vehicles).

Manufacturer: Optic-Electronic Corporation, 11545 Pagemill Road, Dallas, Texas 75243, USA.

Optic-Electronic Gunner's Sight Integrated Ranging Equipment M36-SIRE

Development/Description

The M36-SIRE is a monocular day/night sight for various types of armoured fighting vehicles consisting of a head assembly, laser integrated day sight and passive night vision elbow, power supply and optional commander's remote display.

The head assembly supports the periscope unit in its M119E1 mount and connects the sight to the turret ballistic drive via an adjustable input arm.

The laser integrated day sight contains a seven power magnification optical system and a unity-magnification vision channel. Boresighting and zeroing to the shot group is effected by a simple adjustment with the laser line-of-sight. The laser aim mark is permanently aligned with the sight boresight mark. An optional injection system is provided in the laser for viewing CRT projected information such as a computer aim point and/or thermal display.

Power to SIRE is from the vehicle 24 V DC supply although there are external rechargeable NiCad batteries for use in the case of a primary power source failure.

The whole SIRE assembly can, if required, be integrated with a fire control computer system.

The passive night vision elbow contains a ballistic reticle which can be boresighted with the SIRE laser rangefinder to permit night-time fire control operations and engagements. The elbow uses a 25 mm second-generation image intensifier tube.

Normally the elbow is powered by the vehicle's 24 V DC system but for emergency use and silent watch purposes with the turret power off rechargeable NiCad batteries are fitted.

SPECIFICATIONS

less than 27.27 kg WEIGHT DIMENSIONS 355.6 × 355.6 × 533.4 mm ELEVATION/DEPRESSION +60°/-20°

24 V DC POWER SUPPLY **EMERGENCY BATTERIES** rechargeable NiCad

Unity sight MAGNIFICATION FIELD-OF-VIEW

horizontal 60 10° vertical Night vision passive elbow sight

MAGNIFICATION FIELD-OF-VIEW 7.20

Laser Rangefinder module (including daylight sight)

Transmitter LASER TYPE **OUTPUT ENERGY BEAM WIDTH** Optical channel

MAGNIFICATION **EFFECTIVE APERTURE** 50 mm **EYEPIECE** adjustable focus

Laser receiver FIELD-OF-VIEW 1.5 mrad **EFFECTIVE APERTURE** 50 mm **OPERATING RANGE** 200-10 000 m RANGE ACCURACY ±10 m DISCRIMINATION 50 m RANGE LOGIC first/last pulse DISPLAY 4 digital LED

Status: Production. In service with Thailand (Stingray light tank).

Manufacturer: Optic-Electronic Corporation, 11545 Pagemill Road, Dallas, Texas 75243, USA

Erbium-glass Q-switch, eyesafe

nominal 10 MJ

1.0 rad (90% energy)

Telephone: (214) 349 0190 Telex: 910 8619 312 Fax: (214) 343 7259

M36-SIRE gunner's periscope with image intensification night vision and eyesafe laser rangefinder



Optic-Electronic M26 Muzzle Boresight

Development

The all-metal M26 muzzle boresight is designed to provide precise alignment between the main tank gun and the fire control periscope. Versions are available with suitable carrying cases and sized foot rings to fit the following cannon types: 75, 76, 84, 90, 100, 105, 120, 152 and 165 mm.

Description

The M26 device consists of a telescope mounted on a rigid shaft which secures two foot rings and a spring-loaded locating block. When the shaft is inserted into the gun muzzle, the foot rings and block fit firmly against the

The telescope is designed with its optical path reflected through a right angle to the eyepiece on the side of the device for viewing the target.

SPECIFICATIONS

LENGTH 533.4 mm MAGNIFICATION $\times 7$ FIELD-OF-VIEW 6 FOCAL LENGTH 104 mm

DIOPTER RANGE -1/2 to 1 fixed focus

RETICULE circle diameter 1°; centre dot 0.15 mils

Status: Production as required. In service with a number of undisclosed countries.



Optic-Electronic Corporation M26 muzzle boresight

Manufacturer: Optic-Electronic Corporation, 11545 Pagemill Road, Dallas, Texas 75243, USA

Telephone: (214) 349 0190 Telex: 910 861 0190 Fax: (214) 343 7529

Optic-Electronic Muzzle Reference Collimator

Development/Description

During 1989 the Optic-Electronic Corporation began production of two improved design muzzle reference collimator assemblies for use with 105 mm and 120 mm main tank guns.

The collimator and its mount are integrated into a single precision casting with two mounting methods available for retaining the assembly on the gun tube. For rifled gun barrels a strapping mechanism is recommended whilst smoothbore barrels require an integrated upstand to which the collimator is

The collimator accurately determines the position of the gun muzzle using an f/3.6 optical system with a projected target line weight of 0.5 milliradian. It uses a dark field design with illumination provided by the ambient light during the day and an irradiated radio-luminescent phosphor light source during any low light level conditions.

This is achieved by the use of a sophisticated narrow bandpass beamsplitter and with broad spectral reflectance of better than 90 per cent over the visual spectrum region. The phosphor has a narrow emission band of less than 70 nm width and was chosen for its optimum eye response properties

Due to the phosphor emission as the gun tube cools off, the muzzle position can still be determined as the ambient light level drops and throughout the periods of darkness. To reduce to a minimum the possibility of an external light source illuminating the focal plane from the objective side and 'washing out' the target image of the collimator, a built-in sunshade is provided.

All the optics are designed and mounted in the assembly both to survive the severe mechanical and thermal shock encountered at the muzzle blast and to maintain the optical alignment required during the thermal cycling of the gun tube due to the firing and solar temperature effects.

Status: Production. In service with undisclosed countries.

Manufacturer: Optic-Electronic Corporation, 11545 Pagemill Road, Dallas, Texas 75243, USA.

Telephone: (214) 349 0190 Telex: 910 861 9312 Fax: (214) 343 7529

Optic-Electronic muzzle reference collimator assembly installed on a 120 mm armed M1A1 MBT



Texas Instruments AN/VSG-2 Tank Thermal Sight (TTS)

Development/Description

The AN/VSG-2 bi-ocular thermal imaging infra-red Thermal Tank Sight (TTS) was developed as part of the US Army upgrade programme for the M60 MBT to replace the passive image intensification M35E1 and M36E1 sights from mid-1979 onwards.

Upgraded tanks fitted with the sight are known as the M60A3 TTS. In addition to the US Army's M60A3 fleet, the AN/VSG-2 is also used by the Republic of China (Taiwan) on its indigenous M48 Hybrid MBT design, Saudi Arabia and Turkey (on its M48A5T2 upgrade MBT).

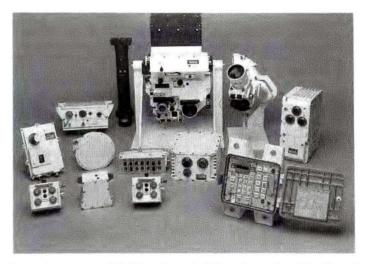
The 120 element HgCdTe detector unit not only improves the night fighting capability of the vehicle but also allows the gunner and the commander to see the external scene on their own individual 40 mm image intensifier tube displays.

Incorporated into the US Army version is the AN/VVG-2 Ruby laser rangefinder unit, whilst the Taiwanese variant uses a Nd-YAG type system.

SPECIFICATIONS

SPECIFICATIONS	
WEIGHT	
head assembly	28.86 kg
gunner's display	15.23 kg
commander's display	16.36 kg
power converter unit	11.14 kg
FIELD-OF-VIEW	
x 1 magnification	$7.8^{\circ} \times 15^{\circ}$
× 8 magnification	$2.6^{\circ} \times 5^{\circ}$
WAVEBAND REGION	7.6-11.75 µ

WAVEBAND REGION 7.6-11.75 μm
POWER SUPPLY 18-30 V DC vehicle system



Texas Instruments AN/VSG-2 thermal sight and complete Fire Control Sysem (TTS)

Status: Production. In service with Saudi Arabia (M60A1 to M60A3 upgrade), Taiwan (M48H MBT), Turkey (M48A5T2 MBT) and US Army (M60A3 TTS MBT).

Manufacturer: Enquiries to: Texas Instruments Incorporated, Electronic Systems Division, Business Development Manager, 2501 W University, MS 8046 McKinney, Texas 75070, USA.

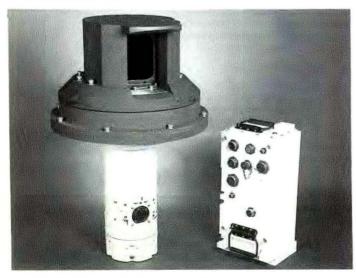
Telephone: (214) 952 2000 Cable: TEXINS

Texas Instruments Tank Commander's Independent Thermal Viewer

Development/Description

The Commander's Independent Thermal Viewer (CITV) has been developed as the Hunter-Killer search element of the M1 Abrams MBT Block II Improvement Programme. It will provide the following capabilities:

 (a) independent stabilised observation facilities with 360° day/night vision and automatic sector scan



Texas Instruments Commander's Independent Thermal Viewer (CITV) for the M1A1/M1A2 MBT

- (b) automatic non-verbal electronic target cueing of the gunner's sight system
- (c) backup visual fire control.

The CITV comprises:

- (a) a gyro-stabilised head sensor assembly
- (b) commander's combined hand controller grip/parameter setting panel
- (c) electronics box
- (d) commander's remote CRT display unit.

SPECIFICATIONS

 WEIGHT
 181.8 kg

 ELEVATION RANGE
 −12° to +20°

 AZIMUTH RANGE
 360°

 FIELDS-OF-VIEW
 2.6° × 3.4°

 wide
 7.7° × 10.4°

Status: Production. In January 1989 Texas Instruments was awarded a \$12 million contract by General Dynamics, Land Systems Division, to develop the CITV for the M1A2 MBT. The CITV is installed in the left side of the M1A2 turret roof forward of the loader's position and gives the tank commander 360° surveillance without moving his head, under both day and night conditions, with the thermal picture being provided on a monitor at his station.

In October 1991 Texas Instruments was awarded a \$119 million contract by General Dynamics Land Systems to produce 377 CITVs and 775 Hull and Turret Electronics Units (H/TEU) for the US Army and the Saudi Arabian Army for M1A2.

Manufacturer: Enquiries to: Texas Instruments Incorporated, Electronic Systems Division, Business Development Manager, 2501 W University, MS 8046 McKinney, Texas 75070, USA.

Telephone: (214) 952 2000 Cable: TEXINS

Texas Instruments Light Armored Vehicle-Air Defense (LAV-AD) Primary Sight System

Development/Description

Texas Instruments has developed the Primary Sight System under a subcontract to General Electric for incorporation into that company's modified Light Armored Vehicle entrant into the US Marine Corp's LAV-AD competition.

The totally integrated assembly will provide a 24-hour air defence monitoring capability with threat detection and tracking, stabilised line-of-sight to allow fire-on-the-move and a modular design to ease field and depot maintenance and allow future system growth.

The system comprises the following modules:

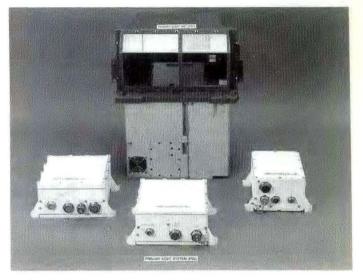
- (a) Primary Sight Unit with thermal FLIR, day TV and an 'eyesafe' carbon dioxide (CO₂) laser rangefinder for passive target acquisition
- (b) Sight Electronics Unit
- (c) Laser Electronics Unit
- (d) Power Converter Unit.

The assembly is suitable for use against both fixed and rotary-wing threats, with a secondary role against ground targets.

Status: Following trials with prototype systems built by General Electric and FMC, the former was selected by the USMC for final development.

Manufacturer: Enquiries to: Texas Instruments Incorporated, Electronic Systems Division, Business Development Manager, 2501 W University, MS 8046 McKinney, Texas 75070, USA

Telephone: (214) 952 2000 Cable: TEXINS



Main components of the Texas Instruments Light Armored Vehicle Air Defense Primary Sight System (PSS)

Texas Instruments Gunner's Primary Tank Thermal Sight (GPTTS)

Development/Description

The Gunner's Primary Tank Thermal Sight (GPTTS) was developed to provide the tank gunner with a fully integrated visible and thermal imaging target aiming gyrostabilised sight for use in day and night battlefield smoke and haze conditions. Direct vehicle fit applications include the Type 88 MBT and the M1 Abrams. With modification it can also be fitted to the Leopard 1 and AMX-30 MBTs.

The GPTTS comprises the following subsystems:

- (a) optional × 8 magnification, 6° field-of-view and unity-magnification, 17° field-of-view visible channel assembly
- (b) dual field-of-view (2.58° × 5° narrow and 7.7° × 15° wide) bi-ocular eyepiece thermal imaging channel assembly

- (c) two-axis line-of-sight stabilised head assembly
- (d) Texas Instruments carbon dioxide (CO_a) laser rangefinder module with first/last pulse logic and a multiple target return indicator
- (e) optional Charge-Coupled Device (CCD) standard TV format camera with through-the-sight video recording capability and remote viewing

Status: Production. In service with South Korea (on 325 second production block Type 88 MBTs).

Manufacturer: Enquiries to: Texas Instruments Incorporated, Electronic Systems Division, Business Development Manager, 2501 W University, MS 8046 McKinney, Texas 75070, USA.

Telephone: (214) 952 2000 Cable: TEXINS

Texas Instruments Lightweight Modular Thermal Sight (LWMS)

Development/Description

The Lightweight Modular Thermal Sight (LWMS) system has been designed for installation on the LAV, Arrowpointe 90 mm, M47 MBT and M48 MBT turrets without any modification work.

It will fit into the space previously occupied by the M32/M36 periscope sights and features three fields-of-view - extra wide, wide and narrow with a monocular eyepiece for the day and thermal vision channels. Stadia and ballistic graticule are also provided.

If required, the LWMS can be integrated with the following equipment:

- (a) full firing solution digital computer with disturbed graticule and built-in test facility
- (b) laser rangefinder module such as the GEC Ferranti Defence Systems Type 520 Nd-YAG 1.064 µm wavelength unit
- (c) chemical warfare directional detector
- (d) TOW optical tracker

- (e) remote fire control CRT display connection for day TV and thermal imagery
- (f) electronics unit for projecting system information/display status through the eyepiece
- (g) mechanical or electrical head mirror drive.

SPECIFICATIONS

WEIGHT 22.7 kg

DIMENSIONS 567 × 238 × 333 mm ELEVATION -20° to +60°

MAGNIFICATION

day channels \times 1 and \times 8

Status: Production as required.

Manufacturer: Enquiries to: Texas Instruments Incorporated, Electronic Systems Division, Business Development Manager, 2501 W University, MS 8046 McKinney, Texas 75070, USA

Telephone: (214) 952 2000 Cable: TEXINS

Texas Instruments Combat Vehicle Thermal Targeting System (CVTTS)

Development/Description

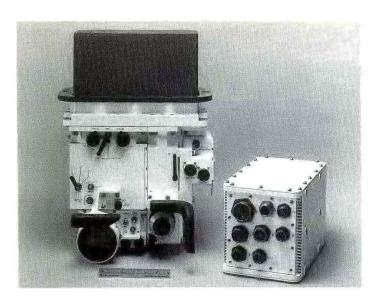
The CVTTS is designed to be adaptable to a wide variety of light armoured vehicles, MBTs and gun systems. It is M36 sight mount compatible.

Its modularity provides two Forward Looking Infra-Red (FLIR) options, four Line-of-Sight (LOS) director options: a separate head mirror, thermal imaging system, visible display and laser rangefinder modules

The sight system comprises the following subassemblies:

- (a) two fields-of-view standard RS-170 video format thermal sensor with reimaging afocal optics, servo controlled scan and thermal references. The system is DC restored with automatic gain/level. A cryogenic linear cooler keeps the detector at its low operating temperature
- (b) two fields-of-view visible channel which combines the direct view visible optional laser rangefinder and RS-170 video format day TV in a single aperture
- (c) optional day TV
- stabilised or unstabilised head mirror option which fits through a standard M36 turret opening
- (e) optional laser rangefinder module
- (f) optional full solution fire control.

544 DAY AND NIGHT SIGHTING SYSTEMS / USA



Status: Production as required. In September 1991 Texas Instruments and Aselsan Military Electronics Industries of Ankara, Turkey were awarded an \$85 million contract by the Turkish Ministry of National Defence to produce 650 CVTTS for the Armoured Infantry Fighting Vehicle (AIFV) programme of the Turkish Army.

Manufacturer: Enquiries to: Texas Instruments Incorporated, Electronic Systems Division, Business Development Manager, 2501 W University, MS 8046 McKinney, Texas 75070, USA.
Telephone: (214) 952 2000 Cable: TEXINS

Texas Instruments Combat Vehicle Thermal Targeting System (CVTTS)

ADDENDA

COMMONWEALTH OF INDEPENDENT STATES

Passive AFV Protection System

Development/Description

Early in 1993 it was disclosed that the Commonwealth of Independent States was developing an active defence system for installation on MBTs such as the T-72 and T-80 which increases their survivability against Anti-Tank Guided Weapons (ATGW) such as the NATO TOW, HOT, MILAN and Hellfire as well as manportable weapons such as the Swedish AT4.

The system, which as yet has no designation, can be fitted onto MBTs while they are being built or backfitted after they have entered service, is fully automatic and provides a high degree of protection through the frontal 180 degree arc of an MBT which typically is the most vulnerable part.

Mounted on the roof of the MBT is a radar system which is constantly scanning for approaching ATGWs. When these threaten the MBT the system automatically activates the active defence system which has a reaction time of typically around 0.05 seconds with the complete system, including the electronics and anti-ATGW elements, weighing between 800 and 1000 kg.

The active defence system is located around the tank turret and fires a small projectile which explodes in front of the incoming ATGW, therefore, neutralising the ATGW before it impacts the MBT.

By early 1993 it is believed that successful trials of this system had been carried out but another two years were needed to complete development. The Commonwealth of Independent States is now seeking partners or funding to enable development work on this system to be completed.

In recent years the Commonwealth of Independent States has been placing increased emphasis on improving the battlefield survivability of its MBTs including the installation of smoke dischargers to cover the frontal arc and the installation of explosive armour (ERA) which protects against ATGW and tank rounds fitted with a High Explosive Anti-Tank (HEAT) warhead.

The new active defence system is just one in a number of systems developed over the last 15 years by Russia with the earliest system being Drozd (Thrush) which was installed on upgraded T-55AD MBTs. Details of Drozd (Thrush) are given in the *Armoured Fighting Vehicle Protection*, *Smoke Dischargers*, *Grenades* and *Decoys* section.

Status: Development. Not yet in production or service.

Manufacturer: Former Soviet state factories.

Shtora 1 AFV Defence System

Development/Description

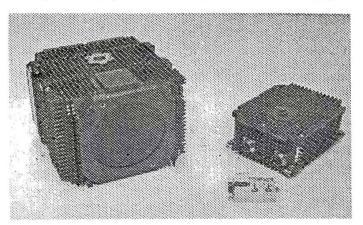
The Shtora 1 armoured fighting vehicle defence system has been developed to increase the battlefield survivability of vehicles against attack from Anti-Tank Guided Weapons (ATGW).

The Shtora 1 system would typically include two TShU1-7 systems plus a laser warning system and various grenade launchers which cover the frontal arc.

The laser warner automatically orients the turret in the direction of the threat and triggers the grenade launcher to create an off-board aerosol cloud. The composition of this screens the tank against laser designators and is claimed to be sufficiently hot to seduce infra-red homing weapons away from the tank itself.

The TShU1-7 was developed by the Zenit Research and Production Corporation and can be installed on MBT's such as the T-72 or T-80 while they are being built or backfitted afterwards.

The system introduces a spurious signal into the guidance circuitry of the incoming missile through the use of coded pulsed infra-red jamming signals



Two of the three components of the TShU1-7 system. On the left is the infra-red jammer and on the right its associated power supply

continuously generated by the system and is claimed to be effective against Western ATGWs such as the TOW, HOT, MILAN and Dragon as well as Eastern ATGWs such as the Sagger AT-3.

The three main components are the infra-red source, power supply and the control panel although the design of the system is modular so that it can be tailored to meet specific user requirements.

The infra-red jamming source is normally mounted on the front of the tank which is the most vulnerable area and incorporates an electrically modulated source of infra-red radiation, special reflector, optical filter and an air cooling system.

The power supply and control unit activates the radiation source and encodes the jamming signal and structurally the unit can be integrated with the infra-red jamming source.

The control panel is normally at the tank commanders station and serves for remote switching on/off of the station and controlling its operation.

The TShU1-7 system has a specified life of 1000 hours, a time between failure of 250 hours and a radiation source life of 50 hours. It operates from a 27 V DC power supply with the infra-red jamming source consuming 1 kW of power.

In addition to being used to jam incoming ATGW, the manufacturer claims that the system also has a target illumination capability.

SPECIFICATIONS TShU1-7

weight not more than 15 kg
CONTROL PANEL

 $\begin{array}{ll} \text{dimensions} & 100\times70\times50 \text{ mm} \\ \text{weight} & \text{not more than 0.30 kg} \end{array}$

Status: Development. Not yet in production or service.

Manufacturer: State factories.

Enquiries to: Electronintorg Ltd, 24/2, ul. Usievicha, 125315 Moscow,

Commonwealth of Independent States.

Telephone: 151 06 40/155 49 12 Telex: 411326

Fax: 151 54 41/151 74 11

FRANCE

Thomson-CFS Camille Fire Control Radar

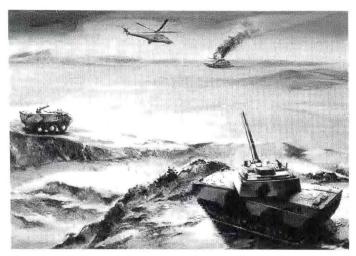
Development/Description

The Camille AFV Fire Control Radar has been developed by the Radars and Countermeasures Division of Thomson-CSF for use in the acquisition of very short range tank or helicopter targets under adverse weather conditions. The detection of the target is then used to cue either the main armament of the tank or an anti-tank missile guidance system.

The sensor unit, which weighs approximately 30 kg, is mounted on the roof on the MBT and covers 120° in azimuth and 30° in elevation. The radar uses millimetre wave technology derived from other programmes that Thomson-CSF have been involved in such as the Romeo obstacle warning radar and the terminally guided MLRS Phase 3 submunition.

Status: Development.

Manufacturer: Thomson-CSF, Radars and Countermeasures Division, 66 rue de Fosse Blanc, PO Box 156, F-92331 Gennevilliers, France.



Artist's impression of MBT (right) and 6×6 APC (left) fitted with Thomson-CSF Camille fire-control radar system

IRAQ

Iraqi ATGW Decoy System

Development/Description

During the 1991 Middle East conflict, a number of Iraqi T-72M1 MBT's of the Republican Guard Division's were observed to be fitted with a roof-mounted electro-optical jammer, or 'Dazzler' as it is also referred to by the Allies. This was first observed on a T-72M1 MBT during a defence equipment exhibition held in Baghdad in 1989.

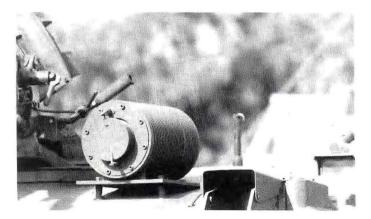
This device was mounted on a small platform on the left side of the turret roof adjacent to the gunner's hatch cover and pointed to the front of the vehicle. The exact origins of the device are not clear, although it could be Chinese

Reports indicate that it was effective in decoying away some types of wire guided anti-tank guided weapon.

Some Iraqi T-72M1 MBT's were also fitted with a roof-mounted laser warning system which may have been of Polish origin as Poland supplied a number of the Iraqi T-72M1 MBT's from their production facilities.

Status: Probably still in limited service with the Iraqi Army.

Manufacturer: Not known.



Close-up of an Iraqi T-72M1 MBT showing roof-mounted ATGW decoy system with optical cover closed

SOUTH AFRICA

Steelcore Heavy Equipment Armour Systems

Development/Description

The Steelcore Heavy Equipment company has manufactured many of the armour bodies installed on mine-protected vehicles developed in South Africa and brief details of some of these bodies are given below:

Two-man Mine Protected Crew Cab

This is fitted onto mine protected versions of the SAMIL 100 (6×6) truck as well as specialised versions such as fuel tankers and recovery vehicles.

It can be installed on ladder type chassis with an engine output of up to 141 kW for 4 \times 4 use and up to 235 kW for 6 \times 6 use.

The cab is of all welded steel construction and provides protection against 7.62 mm (NATO) ball rounds fired from a distance of 30 metres, a triple former Soviet TM57 land-mine anywhere under the vehicle, hand grenades and acid bombs. The windows are of 52 mm armoured glass with provision for personal rifles and a 12.7 mm turret-mounted weapon as well as fresh air ventilation and a 30 litre water tank. Total weight of this cab is 1625 kg.

Nine-man Mine Protection Troop Carrier Body

This is fitted to the Rhino (4×4) mine protected vehicle but can also be fitted onto other troop carrier and patrol vehicle chassis. It provides the same level of protection as the previous two-man protection cab and can be installed on a ladder type chassis with an engine output of up to 96 kW for 4×4 use. The windows are of 52 mm armoured glass with provision for personal rifles, 12.7 mm turret-mounted weapon and fresh air ventilation. It is fitted to the chassis on three points and has a total weight of 2800 kg.

Eleven-man Mine Protection Troop Carrier Body

This was developed for the Bulldog (4×4) mine protected vehicle and can be fitted to a ladder type (4×4) chassis with an engine output of up to 96 kW.

The engine is at the front and drivers protected compartment at the left with the open topped troop compartment at the rear. Access to the latter is by climbing up and over the sides of the vehicle. The sides are hinged horizontally along the centre and can be quickly dropped down to the outside for ease of access.

This welded steel body provides the same degree of protection as the previous two bodies with provision for personal rifle, 12.7 mm turret-mounted weapon, a 100 litre drinking water tank and a 200 litre drinking water tank which is under armour protection. The body is mounted onto the chassis at three points and weighs 2600 kg.

Five-man Mine Protected Crew Cab

This is installed in the Samil 100 (6 \times 6) chassis and is similar to the first two-man mine protected crew cab but is larger as it has seats for five men and a total of four doors, two either side. It is installed on a number of special SAMIL 100 (6 \times 6) truck chassis including the 127 mm (40-round)



The Rhino (4×4) mine protection vehicle has a nine-man fully enclosed body manufactured by Steelcore Heavy Equipment

Valkiri Mk II multiple rocket launcher and Zumlak twin 23 mm self-propelled anti-aircraft gun system. It has provision for personnel rifles and a 12.7 mm turret-mounted rifle, fresh air ventilation and a 200 litre drinking water tank. The cab weighs 2500 kg.

Status: Production as required. In service with South African Defence Force and other countries.

Manufacturer: Steelcore Heavy Equipment, PO Box 8583, Edenglen 1613, South Africa

Telephone: 452 1670 Fax: 452 7194



The new 127 mm (40-round) Valkiri Mk II multiple rocket system has a five-man enclosed body manufactured by Steelcore Heavy Equipment (Christopher F Foss)

UNITED KINGDOM

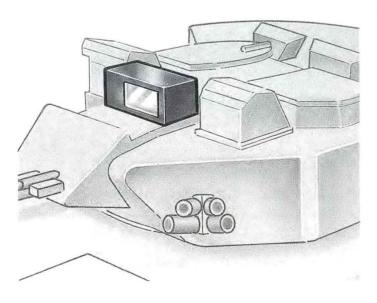
Ferranti International Vehicle support Systems

Development/Description

As a private venture, Ferranti International is marketing a range of Vehicle Support Systems (VSS) to enchance the operational effectiveness and battlefield survivability of AFV's.

By early 1993 a total of seven key sub-systems had been developed to the technology demonstrator phase:

(1) Active armour (as distinct from the older explosive reactive armour, or ERA) would fit over an AFVs vulnerable arc and protect it from Anti-Tank Guided Weapons (ATGW) by engaging them before they hit the vehicle. Optimised warhead detonation ensures damage to all sections of an incoming ATGW and would defeat tandem as well as singlecharge warheads. The active armour would be about a quarter of the weight of ERA.



Each active armour module has a combined passive-active sensor system and a warhead and can detect, confirm and engage an incoming missile or rocket.

- (2) Acoustic arrays would also typically be mounted on the front of the AFV and permit the detection, classification and tracking of air and ground threats in a passive non-line of sight manner.
- (3) With considerable experience in the design, development and production of stabilised helicopter sights, Ferranti would use this technology to provide various roof-mounted sights. Options would include laser designators, laser protection and image intensification channels
- (4) A covert laser communication system called Acquire can be installed to provide voice and data transmission for use in periods of RF silence, jamming or detection. This is applicable to ground-to-ground, groundto-aircraft and aircraft-to-aircraft scenarios and can be configured to the desired power levels and field-of-view.
- (5) The Deceptor, an anti-tank guided missile countermeasure device, is a low cost optional countermeasure that can defeat optically tracked ATGWs operating in the near infra-red waveband. It can counter simultaneous threats approaching over a selected arc coverage, typically 60 degrees.

Deceptor would ground the missile before it strikes the AFV, disrupting the missile engagement by causing erroneous trajectory commands to be accepted.

The systems modular design allows multiple units to be combined for greater coverage. Operating on a regulated 28 V supply, Deceptor comprises an external unit located with an unobscured field-of-view of regard over the required arc of protection while the power supply is located inside the vehicle.

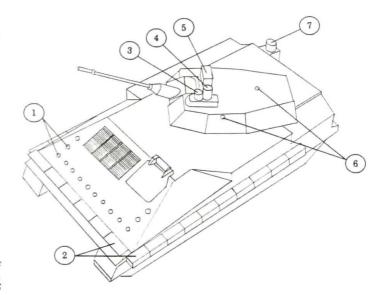
- (6) AWARE covers a range of radar warning or fully Electronic Support Measures (ESM) systems capable of providing identification and source bearing for threat radars for warning or countermeasure initiation.
- (7) Finally, SATCOMMS (Satellite Communications) can be fitted to allow satellite communications while traversing rough terrain by combining a low profile antenna with a gyrostabilised positioning system.

Artist's impression of Deceptor ATGW countermeasure device mounted on the turret of a light armoured fighting vehicle Status: Development.

Manufacturer: Ferranti International, St Mary's Road, Moston, Manchester

M10 OBE, UK

Telephone: (061) 681 2071 Fax: (061) 682 2500



Key Ferranti International Vehicle Support Systems (VSS), (1) Acoustic Arrays, (2) Active Armour, (3) Stabilised Sights, (4) Covert Communications, (5) ATGW Countermeasures System, (6) RWR/ESM System, (7) SATCOMMS

Lotus Engineering Active Suspension System

Development/Description

Early in 1993, Lotus Engineering disclosed that it had been awarded a contract to install its active suspension system on a single example of a M1026 Armament Carrier, Armored, version of the High Mobility Multipurpose Wheeled Vehicle (HMMWV).

The contract to Lotus Engineering was made through Teledyne Continental Motors of the USA by US Army Tank Automotive Command.

AM General has already delivered over 100 000 of the HMMWV to the US armed forces and to a number of export customers.

This contract was awarded following a competition and the M1026 HMMWV was delivered to Lotus Engineering early in 1993. Following the installation of the suspension system, it will be shipped to the USA for extensive trials at TACOM facilities late in 1993.

The HMMWV's conventional springs and dampers will be replaced by

powerful microprocessor controlled hydraulic actuators. This system moves the wheels to respond to and to control body and road inputs into the suspension. The ride quality and handling performance are therefore under full computer control and give a significant increase in cross-country mobility.

Before the US award, Lotus Engineering, under contract to the UK MoD Defence Research Agency, had installed its active suspension system on a British Scorpion Combat Vehicle Reconnaissance (Tracked) light track armoured vehicle. This is now further being improved with the addition of an active track tensioning system under another contract from the Defence Research Agency. Lotus Engineering has built in excess of 50 active suspension prototype vehicles, including systems for the Formula One cars of Team Lotus.

Status: Development.

Manufacturer: Lotus Engineering, Hethel, Norwich, Norfolk NR148EZ, UK. Telephone: (0953) 608000 Fax: (0953) 608300

UNITED STATES OF AMERICA

Inframetrics Infra-Red Imaging System (IRIS)

Description

The IRIS (Infra-Red Imaging System) is a self-contained multi-mission night observation system for surveillance, aiming and sighting in manportable and vehicle roles

It features a four element CMT detector which covers the 7.5 to 12 micron range and a closed cycle Stirling engine cooling system. The scanner is of the dual galvos serial scan type with a frame rate of 25/50 Hz and a line rate of 7866 Hz. The picture is displayed on a 1 inch (2.54 cm) cathode ray tube display.

These, together with the binocular magnifier and other electronics are in a compact housing. The system can operate from either 'C' lithium cells which provide three hours working life or from an external rechargable battery for up to 12 hours. In addition, it may also be used directly from a vehicle battery.

SPECIFICATIONS

DIMENSIONS WEIGHT

 $20.32\times13.97\times25.4~\text{cm}$

6.8 kg

FIELD-OF-VIEW 3.0° $V \times 4.0^{\circ}$ H, 1.5° $V \times 2.0^{\circ}$ H (with

2:1 electro-optic zoom)

INPUT POWER 10

Status: In production. In service with Swiss Army 105 mm gun for fire correction and in service with the US Army on unmanned ground vehicles.

Manufacturer: Inframetrics Inc, 16 Esquire Road, Nort Billerica, MA 01862, USA.

Telephone: (508) 670 5555 Telex: 710 326 0659 Fax: (508) 667 1046



Inframetrics Portable Infra-Red Observation System (IRIS)

Alphabetical Index

7.62 mm TKB-0149 one-man machine gun turret		Alcan Plate aluminium armour		Barcom ANV 90 integrated vehicle navigation system	
12.7 mm CIBI 50 turret		Alenia C215 gunner's articulated telescopic sight		Barr & Stroud LF19 laser rangefinder	
20 mm fixed ammunition		Alenia GAO-4 anti-aircraft system laser rangefinder		Barr & Stroud Automatic muzzle reference system	515
20 mm VCTP turret		Alenia MTL-8 modular laser rangefinder	460	Barr & Stroud computerised thermal and optical fire-	401
25 mm M919 APFSDS-T ammunition			494	control equipment	. 400
30 mm 2A38M cannon			493	system	. 515
30 mm 2A42 cannon			441	Barr & Stroud thermal observation and gunnery sight.	
30 mm 2A72 automatic cannon		Alenia P204 day/night gunner's periscope	493	Barr & Stroud IR26 Thermal Imaging Sensor Head	
30 mm GAU-8/A ammunition	. 156	Alenia P223 vehicle commander's night vision		(TISH)	. 514
30 mm M86 cannon			495	Barr & Stroud tank laser sight	. 514
30 mm M89 cannon			495	Barreiros ammunition	
30 mm RARDEN ammunition		Alenia V 200 vision block	495	Baudouin 6-cylinder diesel engines	223
73 mm 2A28 gun		Alliant Techsystems 24 V electric drive system for		Belgium	
76 mm OTO Melara ammunition		lightweight observation cupolas		AFV fire control systems	
100 mm D-10 series guns	4	Alliant Techsystems 120 mm KE-T round	160	AFV turrets and cupolas	
105 mm ammunition for M101, M102 and M119		Alliant Techsystems 120 mm Smart Target Activated		ammunition	
towed howitzers and M52 and M108 self-propelled	150	Fire-and-Forget (STAFF) 120 mm tank round	111	coaxial machine guns	
howitzers		XM943 Alliant Techsystems advanced armour systems		day and night sighting systems	
105 mm EX 35 low recoil gun 105 mm FRT L44 D1504 Type CN105F1 gun		Alliant Techsystems Automatic Fire-Control System	101	driver day and night vision systems	
105 mm FRT L51 tank gun			407	Weapons of 20 mm and upward	12
105 mm high explosive rocket-assisted projectile		Alliant Techsystems light turret 24 V electrical drive	407	Bendix Stabilisation Reference Package/Position	431
M913	153		375	Determining System (SRP/PDS)	42
105 mm TAM tank turret		Alliant Techsystems lightweight 30 mm ammunition		Bernardini M41 repower package	
105 mm TC canister round		Alliant Techsystems MBT turret 24 V electrical drive		Bharat Electronics tank fire-control system Mk 1A	
105 TGG turret		system	375	Bharat Electronics tank fire-control system Mk 1B	
105 TML turret		AlliedSignal Gyrocompass Navigation System (GNS)		Blair tracks	
115 mm tank gun barrel		AlliedSignal multiple rocket launcher system Position		Blazer air defence turrets	
115 mm U-5TS (2A20) gun	4	Navigation Unit (PNU)	431	Blazer explosive reactive armour	. 17
120 mm compact tank gun (smooth-bore)	28	AlliedSignal Ring Laser Gyro Land Navigation System		Blohm + Voss armour systems	17
120 mm Rheinmetall smooth-bore gun	15	(RLNS)		Bodenseewerk FNA 615 vehicle navigation system	. 41
125 mm D-8 1TM (2A46) smooth-bore gun		Allison Transmission		Bodenseewerk GPA 2000 gun positioning and laying	
140 mm Advanced Tank Cannon (ATAC) system		Allison Transmission X-200-4 transmission	267	system	
140 mm tank gun	28	Allison Transmission X-1100-3B automatic		Bofors 40 mm 40/70B gun	
155 mm ammunition for M114 and M198 towed	â	transmission		Bofors 71 mm combat vehicle illuminating system	
howitzers and M44 and M109 series of self-propelle		Alvis 30 mm turret		Bofors ammunition	
howitzers		Alvis 76 mm turret		Bofors combat vehicle 90 turret	
155 mm expendable jammer XM867 AD/EXJAM		Alvis 90 mm turret		Bofors RBS56 Bill	5
175 mm ammunition for M107 self-propelled gun		Alvis Scorpion repower package		Brazil	20
203 mm (8 in) ammunition for M115 towed howitzer		American ammunition development	140	AFV tyrota and appalan	
and M55 and M110 series of self-propelled howitzers	. 142	Ammunition for 40 mm M1 LAAG and 40 mm M42 SPAAG	156	AFV turrets and cupolas	
nowitzers	142	Ammunition for 76 mm gun M32 on M41 tank		ammunition	
		Ammunition for 90 mm gun on M47 and M48 tanks	150	Breda 40 mm 40L70N Fast Forty gun	
A		and M56 SPATG	157	Breda light turrets	
-		Ammunition for 105 mm gun on M60, M60A1,	107	British Aerospace Defence Swingfire	
AAI 25 mm Minor Calibre Weapons Station	352	M60A3, M48A5 and M1 tanks	157	British AFV armour upgrades for Middle East	
AAI ammunition		Ammunition for 120 mm M256 gun fitted in M1A1/		British Steel armour	
AAI Roller Chain Band track		M1A2 tank	158	Brunswick Defense automatic rammer	
ACTIS Advanced Compact Thermal Imaging System		Ammunition for 152 mm gun in M551 Sheridan light		Brunswick multi-salvo smoke grenade launcher	
AFAP Artillery Fired Atomic Projectiles	140	tank	161	Buck self-protection system	
A F Budge (Sales) retrofit packages	. 244	Anti-tank gun fire-control system, Yugoslav	410	Bulgaria	
AFEDSS Automatic Fire and Explosion Detection and		Argentina		ammunition	7
Suppression System	213	AFV turrets and cupolas			
AFES Automatic Fire Extinguishing Systems		ammunition			
AFS-4 AFV gun-laying and fire-control system	391	smoke dischargers, grenades and decoys		С	
AFV driver's night vision equipment	437	weapons of 20 mm and upward		400.40	
AFV driver's night vision equipment	437 528	Astronautics FCS-10 tank fire-control system	393	C25 25 mm turret	
AFV driver's night vision equipment	437 528 257	Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system	393	C215 gunner's articulated telescopic sight	49
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine AlL radar warning receiver	437 528 257 211	Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system	393 393 393	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems	49
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine ALL radar warning receiver ALCOA Composites M113 modular up-armour kit	437 528 257 211	Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system	393 393 393 394	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret	49 52 30
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine	437 528 257 211 181 492	Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-50 tank fire-control system	393 393 393 394 394	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle	49 52 30
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine AIL radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo	437 528 257 211 181 492	Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-61 tank fire-control system	. 393 . 393 . 393 . 394 . 394 . 394	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret	49 52 30 18
AFV driver's night vision equipment. AGS Armoured Gun System gunner's primary sight. AGT 1500 gas turbine. AIL radar warning receiver. ALCOA Composites M113 modular up-armour kit. AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo.	437 528 257 211 181 492	Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-2010 tank fire-control system	. 393 . 393 . 393 . 394 . 394 . 394 . 393	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar	49 52 30
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine All radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM LWS-2 laser warning system	437 528 257 211 181 492 n 325 204	Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-20 10 tank fire-control system Astronautics TCS-20 10 tank fire-control display	393 393 393 394 394 394 393 440	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar CB 127 VE shield gun racer for 12.7 mm machine	49 52 30 18 29
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine AlL radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM LWS-2 laser warning system AML upgrade kit	437 528 257 211 181 492 n 325 204	Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-2010 tank fire-control system Astronautics tank's driver control and display Athos thermal imaging system	393 393 393 394 394 394 393 440 481	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar CB 127 VE shield gun racer for 12.7 mm machine gun	49 52 30 18 29 30
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine AlL radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM LWS-2 laser warning system AML upgrade kit AMX-30E MBT commander's and gunner's optical	437 528 257 211 181 492 n 325 204 223	Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-2010 tank fire-control system Astronautics tank's driver control and display Athos thermal imaging system Atlas Electronik DMT 90 dual mode tracker	393 393 393 394 394 394 393 440 481	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar CB 127 VE shield gun racer for 12.7 mm machine gun CB shield gun racer for 7.62 mm machine gun	49 52 30 18 29 30
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine All radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM LWS-2 laser warning system AML upgrade kit AMX-30E MBT commander's and gunner's optical equipment	437 528 257 211 181 492 n 325 204 223	Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-2010 tank fire-control system Astronautics tank's driver control and display Athos thermal imaging system Atlas Electronik DMT 90 dual mode tracker Atlas Elektronik FLP-10/EMES 18 Tank Fire-Control	393 393 394 394 394 394 393 440 481 484	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar CB 127 VE shield gun racer for 12.7 mm machine gun CB shield gun racer for 7.62 mm machine gun CCEML Cannon-Calibre Electromagnetic Launcher	49 52 30 18 29 30 31
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine AlL radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM LWS-2 laser warning system AML upgrade kit AMX-30E MBT commander's and gunner's optical	437 528 257 211 181 492 n 325 204 223	Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-2010 tank fire-control system Astronautics tank's driver control and display Athos thermal imaging system Atlas Electronik DMT 90 dual mode tracker Atlas Elektronik FLP-10/EMES 18 Tank Fire-Control System (TFCS) Atlas Elektronik FLT-2/EMES 15 Tank Fire-Control	393 393 393 394 394 394 393 440 481 484	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar CB 127 VE shield gun racer for 12.7 mm machine gun CB shield gun racer for 7.62 mm machine gun CCEML Cannon-Calibre Electromagnetic Launcher CD-850 transmission production CE619 laser rangefinder	49 52 30 29 30 31 4 24
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine AIL radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM LWS-2 laser warning system AML upgrade kit AMX-30E MBT commander's and gunner's optical equipment AMX-30E MBT driver's periscopes		Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-20 10 tank fire-control system Astronautics tank's driver control and display Athos thermal imaging system Atlas Electronik DMT 90 dual mode tracker Atlas Elektronik FLP-10/EMES 18 Tank Fire-Control System (TFCS) Atlas Elektronik FLT-2/EMES 15 Tank Fire-Control System (TFCS)	393 393 393 394 394 394 393 440 481 484	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar CB 127 VE shield gun racer for 12.7 mm machine gun CB shield gun racer for 7.62 mm machine gun CCEML Cannon-Calibre Electromagnetic Launcher CD-850 transmission production	49 52 30 29 30 31 4
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine AIL radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM LWS-2 laser warning system AML upgrade kit AMX-30E MBT commander's and gunner's optical equipment AMX-30E MBT driver's periscopes AN/PVS-5A night vision goggles AN/PVS-5C Model 9876C night vision goggles AN/PVS-7B (improved) Gen III passive night vision		Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-20 10 tank fire-control system Astronautics tank's driver control and display Athos thermal imaging system Atlas Electronik DMT 90 dual mode tracker Atlas Elektronik FLP-10/EMES 18 Tank Fire-Control System (TFCS) Atlas Elektronik FLT-2/EMES 15 Tank Fire-Control System (TFCS) Atlas Elektronik Integrated Operating and Display	393 393 393 394 394 394 393 440 481 484 389	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar CB 127 VE shield gun racer for 12.7 mm machine gun CB shield gun racer for 7.62 mm machine gun CCEML Cannon-Calibre Electromagnetic Launcher CD-850 transmission production CE619 laser rangefinder	49 52 30 30 30 31 44 45 45
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine AlL radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM LWS-2 laser warning system AML upgrade kit AMX-30E MBT commander's and gunner's optical equipment AMX-30E MBT driver's periscopes AN/PVS-5A night vision goggles AN/PVS-6C Model 9876C night vision goggles AN/PVS-7B (improved) Gen III passive night vision goggles		Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-20 10 tank fire-control system Astronautics tank's driver control and display Athos thermal imaging system Atlas Electronik DMT 90 dual mode tracker Atlas Elektronik FLP-10/EMES 18 Tank Fire-Control System (TFCS) Atlas Elektronik FLT-2/EMES 15 Tank Fire-Control System (TFCS)	393 393 393 394 394 394 393 440 481 484 389	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar CB 127 VE shield gun racer for 12.7 mm machine gun CB shield gun racer for 7.62 mm machine gun CCEML Cannon-Calibre Electromagnetic Launcher CD-850 transmission production CE619 laser rangefinder CE624 laser rangefinder	49 52 30 30 30 30 31 45 45 36
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine All radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM LWS-2 laser warning system AML upgrade kit AMX-30E MBT commander's and gunner's optical equipment AMX-30E MBT driver's periscopes AN/PVS-5A night vision goggles AN/PVS-5B (model 9876C night vision goggles AN/PVS-7B (improved) Gen Ill passive night vision goggles AN/PVS-7B Model 1500 night vision goggles		Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-20 10 tank fire-control system Astronautics tank's driver control and display Athos thermal imaging system Atlas Electronik DMT 90 dual mode tracker Atlas Elektronik FLP-10/EMES 18 Tank Fire-Control System (TFCS) Atlas Elektronik FLT-2/EMES 15 Tank Fire-Control System (TFCS) Atlas Elektronik Integrated Operating and Display System - IBAS Atlas Elektronik MOLF Modular Tank Laser Fire-control	393 393 393 394 394 394 393 440 481 484 389 388	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar CB 127 VE shield gun racer for 12.7 mm machine gun CB shield gun racer for 7.62 mm machine gun CCEML Cannon-Calibre Electromagnetic Launcher CD-850 transmission production CE619 laser rangefinder CE624 laser rangefinder CE 10 electric turret drive system CE 15 electric turret drive system CE 24 electric turret drive system	49 52 30 30 30 31 44 45 45 36 36 36
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine AlL radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM LtwS-2 laser warning system AML upgrade kit AMX-30E MBT commander's and gunner's optical equipment AMX-30E MBT driver's periscopes AN/PVS-5E Model 19876C night vision goggles AN/PVS-7B (improved) Gen III passive night vision goggles AN/PVS-7B Model 1500 night vision goggles		Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics tank's driver control and display Athos thermal imaging system Atlas Electronik DMT 90 dual mode tracker Atlas Elektronik FLP-10/EMES 18 Tank Fire-Control System (TFCS) Atlas Elektronik FLT-2/EMES 15 Tank Fire-Control System (TFCS) Atlas Elektronik Integrated Operating and Display System - IBAS Atlas Elektronik MOLF Modular Tank Laser Fire-control system	393 393 393 394 394 394 393 440 481 484 389 388	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar CB 127 VE shield gun racer for 12.7 mm machine gun CB shield gun racer for 7.62 mm machine gun CCEML Cannon-Calibre Electromagnetic Launcher CD-850 transmission production CE619 laser rangefinder CE624 laser rangefinder CE 10 electric turret drive system CE 15 electric turret drive system CE 24 electric turret drive system CE 40 electric turret drive system	49 52 30 30 30 31 44 45 45 36 36 36 36
AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine AlL radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM LtWS-2 laser warning system AML upgrade kit AMX-30E MBT commander's and gunner's optical equipment AMX-30E MBT driver's periscopes AN/PVS-5A night vision goggles AN/PVS-5C Model 9876C night vision goggles AN/PVS-7B (improved) Gen Ill passive night vision goggles AN/PVS-7B Model 1500 night vision goggles AN/VS-3 driver's thermal viewer AN/VS-3 Tank Thermal Sight (TTS)		Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-2010 tank fire-control system Astronautics tank's driver control and display Athos thermal imaging system Atlas Elektronik FLP-10/EMES 18 Tank Fire-Control System (TFCS) Atlas Elektronik FLT-2/EMES 15 Tank Fire-Control System (TFCS) Atlas Elektronik integrated Operating and Display System – IBAS Atlas Elektronik MOLF Modular Tank Laser Fire-control system Atlas Elektronik wehicle Integrated Command and	393 393 393 394 394 394 393 440 481 484 389 388	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar CB 127 VE shield gun racer for 12.7 mm machine gun CB shield gun racer for 7.62 mm machine gun CEML Cannon-Calibre Electromagnetic Launcher CD-850 transmission production CE619 laser rangefinder CE624 laser rangefinder CE 10 electric turret drive system CE 15 electric turret drive system CE 24 electric turret drive system CE 40 electric turret drive system CE 40 electric turret drive system CE 10 electric turret drive system CE 40 electric turret drive system CE GM-09 tank fire-control system	49 52 30 30 30 31 45 45 36 36 36 36
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AFV driver's night vision equipment AGS Armoured Gun System gunner's primary sight AGT 1500 gas turbine AlL radar warning receiver ALCOA Composites M113 modular up-armour kit AMCORAM Ltd APS-3 AMCORAM Ltd APS-3 AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM Ltd WP-7 under armour overhead weapo post AMCORAM LWS-2 laser warning system AML upgrade kit AMX-30E MBT commander's and gunner's optical equipment AMX-30E MBT driver's periscopes AN/PVS-56 model 9876C night vision goggles AN/PVS-78 (improved) Gen Ill passive night vision goggles AN/PVS-78 model 1500 night vision goggles AN/PVS-78 model 1500 night vision goggles AN/VS-2 Tank Thermal Sight (TTS) AN/VG-2 Tank Thermal Sight (TTS) AN/VVS-2 passive driver's night vision viewer AN/VVS-501 passive night driving viewer AN/VVS-501 passive night driving viewer ANX 950/TCV80 laser rangefinder APX M550/TCV80 laser rangefinder APX M550/TCV80 laser rangefinder ARMOX armour ARMSCOR ammunition ARMSCOR ammunition ARMSCOR vehicle smoke concealment system AS90 powerpack AT-2 Swatter AT-3 Sagger AT-4 Spigot AT-5 Spandrel AT-6 Spiral AT-8 Songster AT-10 Stabber AT-11 Sniper ATAC 140 mm Advanced Tank Cannon system ATATS Automatic Target Acquisition and Tracking System ATATS Automatic Target Acquisition And Armamen	437 528 257 211 181 181 492 7 325 204 423 509 446 444 450 450 454 470 448 449 425 470 117 196 412 243 53 53 53 52 51 50 41 382 546 376 399 351 349 2566 277 156	Astronautics FCS-10 tank fire-control system Astronautics FCS-20 tank fire-control system Astronautics FCS-30 tank fire-control system Astronautics FCS-40 tank fire-control system Astronautics FCS-50 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-61 tank fire-control system Astronautics FCS-20 to tank fire-control system Astronautics tank's driver control and display Athos thermal imaging system Atlas Electronik DMT 90 dual mode tracker Atlas Electronik DMT 90 dual mode tracker Atlas Elektronik FLT-2/EMES 18 Tank Fire-Control System (TFCS) Atlas Elektronik FLT-2/EMES 15 Tank Fire-Control System (TFCS) Atlas Elektronik MOLF Modular Tank Laser Fire-control System – IBAS Atlas Elektronik webicle Integrated Command and Information System – IFIS Australia ammunition Australia and Defence Industries Ltd ammunition Austria AFV fire control systems AFV turrets and cupolas automatic loaders and flick rammers coaxial machine guns fire detection and suppression Avenger laser rangefinder Avimo Laser Warming Device LWD 2 1 Avimo NV40 gunner's passive night vision periscope Avimo NV(L) 3001 day/night laser rangefinder sight family Avimo NV 46 commander's passive night vision periscope Avimo TL 10-T articulated telescope laser rangefinder Avinoics Land Navigation System (LNS) Azimuth Position and Elevation System (APES) B BAT-30 computerised fire-control system BIG2 commander's night vision goggles BM8025 night aiming and observation system BIG2 commander's night vision system BRO14 ADV retrofit programs BTM family of light turrets Baird AN/VVS-2 and NDS-2 passive driver's night vision viewer	393 393 393 394 394 394 481 484 389 388 390 389 390 69 69 69 292 65 48 213 3471 207 511 512 466 428 427	C215 gunner's articulated telescopic sight CAI armoured vehicle optical systems CAPRE 20 mm turret CAV Composite Armored Vehicle CB30 30 mm turret CB 60 HB shield gun racer for 60 mm mortar CB 127 VE shield gun racer for 12.7 mm machine gun CB shield gun racer for 7.62 mm machine gun CCEML Cannon-Calibre Electromagnetic Launcher CD-850 transmission production CE619 laser rangefinder CE624 laser rangefinder CE 10 electric turret drive system CE 15 electric turret drive system CE 24 electric turret drive system CE 24 electric turret drive system CEIEC GM-09 tank fire-control system CEIEC Type 82 tank laser rangefinder CEITICS Commander's Extended Link Thermal Imagir Combat Sight CERACHOC ceramic armour systems CF 570 CCD video camera for armoured vehicles CHAPS Chamberlain Armor Protection Systems CILAS TCY107 laser rangefinder CILAS TCY901 laser rangefinder CILAS TGY901 laser rangefinder CILAS TM5301 Eyesafe laser rangefinder CILAS TOS01 laser rangefind	499 522 300 311 300 311 311 311 311 311 311 311

Cadillac Gage Textron In-arm suspension systems		Diehl 120 mm wehicle tragmentation grenade		۴	
Cadillac Gage Textron machine gun turret	358	Diehl ammunition programme	94	FCS-10 tank fire-control system	
Cadillac Gage Textron turret power control systems Cadillac Gage Textron twin/combination machine gun	373	Diehl Remscheid armour systems Diehl track system		FCS-20 tank fire-control system	
(1 m) turret	358	Directional Gyro Indicator (DGI)	424	FCS-40 tank fire-control system	. 394
Cadillac Gage Textron weapon/turret stabilisation	274	Drozd (Thrush) dynamic defence system		FCS-50 tank fire-control system	
systems		Dunlop suspension systems	204	FCS-61 tank fire-control systemFCS-2010 tank fire-control system	
Canada				FFG M41 repower package	. 227
AFV fire control systems AFV turrets and cupolas		E		FFG M113 APC modernisation FIN 1155 land navigation and attitude reference	. 228
ammunition				system	. 425
land navigation systems Cannon, 105 mm M68		E4A1 two-man low-profile turret E6-II-25 gun mount		FIN 5500 land navigation and attitude reference system	126
Cannon ammunition (CIS)		E6-IIA1 gun mount		FLP-10/EMES 18 Tank Fire-Control System (TFCS)	
Castor thermal imaging system for armoured vehicles	483	E23 one-man turret	. 314	FLT-2/EMES 15 Tank Fire-Control System (TFCS)	. 388
Centaur tank weapon control system		EBO ammunition		FMC 12.7 mm machine gun turret FMC 25 mm Autocannon turret	
Centurion tank commander's cupola	324	EFS M41 diesel repower package	. 221	FMC 25 mm electric drive turret	356
Chamberlain Armor Protection Systems (CHAPS) Chamberlain Manufacturing Corporation ammunition .		EFSC-3 tank fire-control system E*GLE laser rangefinder kit		FMC 25 mm Enclosed Weapon StationFMC 25 mm two-man turret	
Chartered Industries of Singapore Advanced Compact	140	EGTD Block III demonstration Electric Gun and Turret	. 403	FMC 40 mm/12.7 mm Enclosed Weapon Station	
Thermal Imaging System (ACTIS)		Drive		FMC Cannon-Calibre Electromagnetic Launcher	40
Chieftain No 17 Mark 2 AFV cupola		EIREL infra-red countermeasures system EL-OP BAT-30 computerised fire-control system		(CCEML)FMC Electromagnetic Focused Technology	42
China, People's Republic of		EL-OP Day/Night Range Sight (DNRS)		Demonstrator (EMFTD)	40
AFV fire control systems		EL-OP High Repetition Laser Rangefinder (HRLR) and High Repetition Laser Rangefinder-Eye Safe		FMC Electrothermal-Chemical (ETC) gun propulsion system	27
AFV fire control systems		(HRLR-ES)	. 459	FMC pulsed power development	
coaxial machine guns	48	EL-OP mini-laser tank rangefinder	459	FMC track shoes	276
day and night sighting systems		EL-OP MSZ-2 gunner's day/night periscope EL-OP No 5157 second-generation night vision	. 490	FMC/US Army 9-MJ Electrothermal skid gun module . FMC/US Army Laboratory Electrothermal-Chemical	38
laser rangefinders		goggles		gun development	38
vehicle-mounted anti-tank guided weapons		EL-OP No 6139 compact driver's night viewer		FMS Corporation AFV upgrades	
Chinese-United States collaboration		EL-OP passive night vision elbow telescope EL-OP Red Tiger tank fire-control system		FN 7.62 mm GPMGFN 12.7 mm M2 HB (QCB) machine gun	
Cockerill C25 25 mm turret	294	EL-OP tank laser rangefinder	. 459	FNA 50 vehicle navigation system	419
Cockerill CB30 30 mm turret Cockerill CSE 90 mm turret		EMDG TRIGAT Programme EMFTD Electromagnetic Focused Technology	57	FNA 55 vehicle navigation system FNA 615 vehicle navigation system	
Collins Mission Planning Station for Trooper™		Demonstrator	40	FOA 25 FOA 50 vehicle orientation systems	420
handheld/vehicular GPS receiver	429	ENOSA AMX-30E MBT commander's and gunner's		FOREX SA ammunition	
Collins Trooper™ handheld/vehicular GPS receiver	429	optical equipment ENOSA AMX-30E MBT driver's periscopes		FSC-530 fire-control system for recoiless gunsFV600 upgrades	
Combat Vehicle Armament Technology (COMVAT)	44	ENOSA improved Mk 7 Laser Tank Fire-Control System	n	FVC 102 lightweight cupola	
Combat Vehicle Command and Control (CVC ²)		(LTFCS) for M48A5E MBT ENOSA PCN night driving periscope series		FVH 300 high angle 7.62 mm or 12.7 mm machine gun hatch	2/15
Commonwealth of Independent States	. 207	ENOSA PCN flight driving periscope series		FWM gun control and stabilisation systems	
addenda		ENOSA PP-02 observation and aiming periscope	. 508	Fairey Hydraulics autoloaders	67
AFV fire control systems		ENOSA PP-03 aiming periscopeEOTS Hughes Electro-Optical Tracking System		Ferranti International vehicle support systems Finland	547
ammunition	81	ERBER 105 mm HE EM 20 carrier round		ammunition	87
armour systems		ERFCDS Extended Range Gunnery Fire-Control	407	France addenda	546
driver day and night vision systemsland navigation systems		Demonstration System	. 407	AFV engines, transmissions and powerpacks	
smoke dischargers, grenades and decoys		equipment	367	AFV fire control systems	
vehicle-mounted anti-tank guided weaponsweapons of 20 mm and upward		ESD High Integration Technology Tank Fire-Control System (HITT-FCS)	402	AFV turrets and cupolas	
Companhia Brasileira de Cartuchos (CBC) ammunition	74	ESD M41 gun control system	368	armour systems	168
Composite Armored Vehicle (CAV) Composite developments (USA)		ESD Main Battle Tank (MBT) gun control system ESTER 10 laser rangefinder for AFVs		automatic loaders and flick rammers coaxial machine guns	
Computing Devices Canada Automatic Target	. 102	EXPAL ammunition		day and night sighting systems	
Acquisition and Tracking System (ATATS)	. 382	Eagle Tx diesel engine		driver day and night vision systems	437
Computing Devices Canada commander's display panel	412	Egypt ammunition	84	land navigation systemslaser detectors	
Computing Devices Canada improved computer		armour systems	167	laser rangefinders	456
control panel	. 380	smoke dischargers, grenades and decoys weapons of 20 mm and upward		smoke dischargers, grenades and decoyssuspensions	
computer system	. 379	Eland night sight adaptor Type NA-10		weapon control and stabilisation systems	
Computing Devices Canada M48 ballistic computer	201	Elbit 1 inch bi-ocular armoured vehicle display Elbit all-electric turret/gun drive and stabilisation	489	weapons of 20 mm and upward	
system	. 301	system	366	Francis B WIlmott suspension components Fraser-Volpe M19A1 driver's night periscope	
control system	. 380	Elbit CELTICS Commander's Extended Link Thermal	400	Full-Solution Tank Fire-Control System	408
Computing Devices Canada Mission Management Computer System	381	Imaging Combat Sight	489		
Computing Devices Canada Vehicle Command and		system	366		
Tactical Information System (VCTIS) Condor commander's day/night sighting system		Elbit/EL-OP Knight family of Advanced Tank fire Control Systems (ATFCS)	305	G	
Condor diesel engines		Elbit/EL-OP Lansadot family of armoured vehicle fire-	333	GALIX combat vehicle protection system	188
Creusot-Loire Industrie armour plates	. 170	control systems	395	GAQ-4 anti-aircraft system laser rangefinder	
Crew Bay explosion, detection and suppression system	214	Elbit/EL-OP Matador family of tank fire-control systems	396	GBT 155 155 mm gun turret	338
Cummins AS90 powerpack	. 243	Elbit/EL-OP tank fire-control systems		systems	
Cummins diesel engines	. 257	Electronics & Space Corporation Ground-Launched Hellfire-Heavy (GLH-H) turret	261	GE Aerospace Armored Gun System (AGS) all-electric stabilised turret drive system	
Czech Republic and Slovakia AFV fire control systems	. 384	Electronics & Space Corporation TOW Under Armour	301	GE Aerospace/Elbit Block III demonstration Electric	3/3
		(TUA) turret		Gun and Turret Drive (EGTD)	
		Eloptro Eland night sight adaptor Type NA-10 Eloptro integrated day/night gunner's sighting system		GE HMPT-500 transmission	
D		GS-21S	504	GEC Avionics Azimuth Position and Elevation System	
DANAOS Day And Night Artillery Observer System	170	Eloptro laser elbow Type LE-20 Eloptro LR 20 laser rangefinder		(APES)GEC Avionics Land Navigation System (LNS)	
DARPA LAV-25 appliqué armour system		Eloptro LT-20 laser rangefinder		GEC Ferranti Defence Systems Type 453 laser warnin	
DEFTEC 105 mm HEAT-T round		Eloptro ND-15 night driverscope		receiver	
DGFM 20 mm VCTP turret DGFM 76 mm grenade launching system		Eloptro ND-20 night driver's periscope Eloptro night elbow Type NE-20		GEC Sensors Multisensor platform GEC Sensors SS100/SS110 night sights	
DGFM 105 mm TAM tank turret	291	Eloptro night vision adaptor NA-20	506	GEC Sensors SS120 commander's night sight	517
DIVT 13 night gunsight system DMT 90 dual mode tracker		Eloptro TV camera adaptor TE-20		GEC Sensors SS122 series armoured vehicle day/nigl	
DNRS Day/Night Range Sight		Eltro CE619 laser rangefinder		GEC Sensors SS130 passive night driving periscope	
DRAGAR 25 mm turret	302	Eltro CE624 laser rangefinder	458	GEC Sensors SS141, SS142 commander's night and	E 10
Daewoo Corporation ammunition		Eltro CE628 laser rangefinder Eltro CE632 laser rangefinder		SS162 commander's day vision periscopes GEC Sensors SS180 armoured vehicle day/night	518
David Brown P40 transmission	. 252	Engine Bay fire detection and suppression system	215	sight	
David Brown TN37 transmission		Ericsson gunner's integrated tank laser sight Eurometaal ammunition		GEC Sensors SS500 series armoured vehicle thermal sights	
David Brown transmissions, new	251	Euromissile HOT	55	GEC Sensors Tank Thermal Sensor (TTS)	
Delco LAV-25 25 mm turret		Euromissile HOT Mephisto system		GEC-Ferranti FIN 1155 land navigation and attitude	405
Delco thermal sight for the LAV-25 Denmark	526	Euromissile HOT UTM 800 turret Euromissile MILAN		reference system	425
AFV engines, transmissions and powerpacks		Euromissile MILAN Compact Turret (MCT)	323	reference system	426
Detroit Diesel Corporation engines Deutsche Aerospace AG Common Opto-electronic	260	Europa Metalli – LMI ammunition Explosive reactive armour, CIS		GEC-Ferranti Positioning and Azimuth Determining System (PADS) Mk 2	426
Laser Detection System (COLDS)	204	Explosivos Da Trafaria SA ammunition		GEC-Ferranti Type 520 laser rangefinder	

GEC-Ferranti Type 629 lightweight modular laser		Haley & Weller vehicle grenades		Israel Aircraft Industries Nimrod	. 58
rangefinder	466	Hardhat ATGW decoy system		Italy	000
GEC-Marconi Dynamics Systems Tank Anti-Missile	200		520	AFV engines, transmissions and powerpacks	
System (TAMS)		Helio buffered mounts for 7.62 mm and 12.7 mm machine guns	211	AFV fire control systems AFV turrets and cupolas	
GITS GMHE Integrated TOW Sight			342	ammunition	
GKN light turret			344	coaxial machine guns	
GLH-H Ground-Launched Hellfire-Heavy Turret		Helio FVH 300 high angle 7.62 mm or 12.7 mm	- TO 12 W.	day and night sighting systems	
GM-09 tank fire-control system		machine gun hatch	345	driver day and night vision systems	
GN1 night vision goggles		Helio HMD 848 lightweight, fighting vehicle,		laser rangefinders	
GNP 55 gunner's night vision periscope		commander's cupola	344	tracks	
GP/NVG-1 night vision goggles		Helio Mirror Company LWD 21 Laser Warning		weapons of 20 mm and upward	22
GPA 2000 gun positioning and laying system		System			
GPG-20 20 mm synchroniser test device		Helio multipurpose grenade discharger systems		j.	
GPS gyrostabilised Gunner's Primary Sight		Helio No 16 and No 26 lightweight cupolas		J	
GPS-LOS Gunner's Primary Sight Line-of-Sight	526	Helio No 27 lightweight AFV cupola Heliopolis Company ammunition		JANUS fire-control system	400
Subsystem, M1A2	531	Hercules 120 mm X-ROD autonomous tank round		Japan	400
GPTTS Gunner's Primary Tank Thermal Sight		Hercules 155 mm Unicharge		AFV fire control systems	401
GRL-76-10 76 mm tank close defence system		Hispano-Suiza H 60 series of turrets		coaxial machine guns	
GS-21S integrated day/night gunner's sighting		Hispano-Suiza Lynx 90 turret		tank ammunition	
system	504	Hispano-Suiza Mangouste 60 mm/12.7 mm turret	301		
Galileo ATREOST tank fire-control system		Hispano-Suiza Puma cupola			
Galileo JANUS fire-control system			301	К	
Galileo OG 14 L2B tank laser fire-control system		Honeywell Modular Azimuth Position System (MAPS)		KONII - J. J. L. L. L. L.	001
Galileo TURMS laser tank fire-control system		Horstman Defence Systems gun control equipment		KONI hydraulic shock absorbers	281
General Dynamics ETC		Horstman Defence Systems powerpacks Horstman Defence Systems suspensions		KTW 18m daylight/thermal imaging alignment collimator	195
General Electric liquid propellant guns		Hsing Hua ammunition		KUKA gun mount E6-II-25	
Germany	50	Hughes AN/VAS-3 driver's thermal viewer		KUKA gun mount E6-IIA1	
AFV engines, transmissions and powerpacks	227	Hughes Armoured Gun System (AGS) gunner's primary		KUKA load assist device for 155 mm artillery systems .	
AFV fire control systems		sight		KUKA one-man turret E23	
AFV turrets and cupolas		Hughes BGM-71 TOW		KUKA two-man low-profile turret E4A1	
ammunition	94	Hughes day/night gunner's Integrated Sight Unit		KUKA two-man Marder 1 turret	
armour systems	171	(ISU)		KUKA Type 605 12.7 mm turret	319
automatic loaders and flick rammers		Hughes Day/Night Range Sight (DNRS)		KVH MV103 series digital fluxgate compasses	
coaxial machine guns		Hughes Electro-Optical Tracking System (EOTS)		Kader 76 mm smoke grenade launcher system	
day and night sighting systems		Hughes GMHE Integrated TOW Sight (GITS)		Kader M113A2 add-on armour kit	
land navigation systems		Hughes gyrostabilised Gunner's Primary Sight (GPS)	526	Kaha screen smoke grenades	188
laser detectors		Hughes High Repetition Rate Eyesafe laser	100	Kaha Type 270/M239 66 mm smoke grenade	107
laser rangefinders		rangefinder	468	launcher	187
smoke dischargers, grenades and decoys suspensions		Hughes Infra-Red Equipment (HIRE) for gunner's periscope sights	E27	Kearfott Land Navigation System (LNS) for combat/ surveillance vehicles	122
tracks		Hughes Low Repetition Rate Eyesafe laser	321	Kearfott Miniature Integrated Land Navigation System	430
weapon control and stabilisation systems		rangefinder	469	(MILNAV)	433
weapons of 20 mm and upward		Hughes M1 Abrams Thermal Imaging System (TIS)		Kearfott Modular Azimuth Position System (MAPS)	
Giat 45 mm Case Telescoped Ammunition (CTA)	200	Hughes M1 MBT laser rangefinder		Kearfott Modular Azimuth Positioning System with	,
cannon	12	Hughes M1A2 Gunner's Primary Sight Line-of-Sight		Global Positioning System (MAPS/GPS)	432
Giat Industries 12.7 mm CIBI 50 turret		Subsystem (GPS-LOS)	531	Kentron ZT-3 Swift	58
Giat Industries 20 mm CAPRE turret		Hughes Second Generation Tank Sight (SGTS)		Kidde-Graviner Crew Bay explosion, detection and	
Giat Industries 20 mm M621 (F1) cannon		Hypervelocity (HVM) Programme	62	suppression system	214
Giat Industries 20 mm M693 (F2) cannon				Kidde-Graviner Engine Bay fire detection and	
Giat Industries 25 mm DRAGAR turret		TV		suppression system	
Giat Industries 25 mm Model 811 automatic gun Giat Industries 30 mm Model 781 automatic gun				Kidde-Graviner Integrated Control Unit	
Giat Industries 80 mm smoke canisters		IBAS Integrated Operating and Display System	390	Kladivo tank fire-control system Knight family of Advanced Tank Fire Control Systems	. 304
Giat Industries 81 mm gun-mortar turret (TMC 81)		IFIS vehicle Integrated Command and Information	330	(ATFCS)	395
Giat Industries 81 mm mortar turret (TMR 81)			390	Kollmorgen Model 220 fire control sight	
Giat Industries 81 mm rapid fire mortar		INDEP ammunition		Kollmorgen Model 317 night vision kit for M20 sight	
Giat Industries 90 mm CN90F3 gun		IR26 Thermal Imaging Sensor Head (TISH)		Kollmorgen Model 910 integrated sight	
Giat Industries 90 mm CS Super (Super 90) gun		IRIS Infra-Red Imaging System	548	Kollmorgen Model 938 commander's weapon station	
Giat Industries 90 mm F1 gun		ISFCS-212 Image Stabilised tank Fire-Control System		sight	
Giat Industries 105 mm 105/57 gun		ISU day/night gunner's Integrated Sight Unit	528	Kollmorgen Model 939 gunner's auxilliary sight	535
Giat Industries 105 mm 105 G1 gun	8	ITS International Thermal Sight	526	Kollmorgen Model 957 squad leader's search	
Giat Industries 105 mm 105 G2 gun		ITT Defense improved AN/PVS-7B Gen III passive night		periscope	533
Giat Industries 105 mm CN105F1 gun		vision goggles		Kollmorgen Model 998 fire control backup sight	
Giat Industries 105 mm F2 (MECA) gun		IVECO FIAT family of diesel engines	239	Kollsman Day/Night Range Sight (DNRS) Korea Explosive Group ammunition	
Giat Industries 105 TML turret		AFV fire control systems	391	Korea, South	. 111
Giat Industries 120 mm smooth-bore gun F1		ammunition		ammunition	109
Giat Industries 120 mm smooth-bore gun G1		Inframetrics Infra-Red Imaging System (IRIS)		tracks	
Giat Industries ammunition	88	Institute of Optronics AN/PVS-5A night vision		Krauss-Maffei hydraulic bump stops	
Giat Industries armour systems		goggles	444	Kvaerner-Eureka armoured launching turret for TOW	
Giat Industries Lancelot HOT turret	313	International		missile systems	. 33
Giat Industries Mascot remote-controlled 7.62 mm	211	AFV fire control systems			
machine gun mount		AFV turrets and cupolas			
Giat Industries Toucan I turret Giat Industries Toucan II turret		vehicle-mounted anti-tank guided weaponsweapon control and stabilisation systems		I	
Giat Industries Toucan II turret		weapons of 20 mm and upward		Ļ	
Greece	237	Intertechnik 155 mm M109 rammer		L20 series sight laser rangefinders	521
ammunition	100	Intertechnik EFS explosion suppression system		L50 series sight laser rangefinders	
smoke dischargers, grenades and decoys		Intertechnik MFS engine compartment fire		LA7 laser rangefinder	
Guns Orientation and Navigation System (GONS)	423	extinguishing system	213	LAV-105 mm weapon system	
		Iran		LAV-AD Light Armoured Vehicle-Air Defense primary	
A025		ammunition	102	sight system	
н		Iraq		LCAMP Chinese-United States collaboration	
11.60	200		546	LD-TS laser rangefinder for T-55 MBT gunner's sight	. 464
H 60 series of turrets HAFCS Howitzer Advanced Fire-Control System		ammunitionarmour systems		LE-20 laser elbow LF19 laser rangefinder	
HDTI 2000 compact thermal imaging system		Iskra EFSC-3 tank fire-control system		LLLTV aiming and observation system with IR scanner	
HIRE Hughes Infra-Red Equipment for gunner's	5 10	Iskra laser irradiation detector and warner		Type PZB 200/IRS 100	. 485
periscope sights	527	Iskra LD-TŠ laser rangefinder for T-55 MBT gunner's		LPT 105 mm Low-Profile Turret	. 346
HITT-FSC High Integration Technology Tank Fire-		sight	464	LR 20 laser rangefinder	. 46!
Control System		Iskra TLMD-3 tank laser rangefinder	464	LRS 5 fire-control system	. 378
HL 33 daylight panoramic observation telescope		Israel	11000	LRS 7 fire-control system	
HL-70 commander's gyrostabilised panoramic sight	477	AFV engines, transmissions and powerpacks		LSG 1000 transmissions	
HMD 848 lightweight, fighting vehicle, commander's	244	AFV turrets and symples		LSG 2000 transmissions	
cupola HMPT-500 transmission		AFV turrets and cupolas		LSG 3000 transmissions	
HMPT-1000 transmission		ammunitionarmour systems		LT-20 laser rangefinderLTFCS improved Mk 7 Laser Tank Fire-Control System	
		day and night sighting systems		for M48A5E MBT	
HNV- I holographic doddles				LUNOS Lightweight Universal Night Observation	
HNV-1 holographic goggles HOT Euromissile		driver day and flight vision systems			4.41
	55	driver day and night vision systems		System	. 44
HOT Euromissile HRLR High Repetition Laser Rangefinder and HRLR-ES High Repetition Laser Rangefinder-Eye Safe	55	fire detection and suppression land navigation systems	213 421	LV5 laser rangefinder	
HOT Euromissile HRLR High Repetition Laser Rangefinder and HRLR-ES High Repetition Laser Rangefinder-Eye Safe HSWL 106 transmission	55 . 459 . 234	fire detection and suppression land navigation systems laser detectors	213 421 204	LV5 laser rangefinder LV350 series laser rangefinders	46
HOT Euromissile HRLR High Repetition Laser Rangefinder and HRLR-ES High Repetition Laser Rangefinder-Eye Safe HSWL 106 transmission HSWL 194 transmission	55 . 459 . 234 . 232	fire detection and suppression land navigation systems laser detectors laser rangefinders	213 421 204 459	LV5 laser rangefinder LV350 series laser rangefinders LV400 series laser rangefinders	46 46
HOT Euromissile HRLR High Repetition Laser Rangefinder and HRLR-ES High Repetition Laser Rangefinder-Eye Safe HSWL 106 transmission HSWL 194 transmission HSWL 284 transmission	55 . 459 . 234 . 232 . 232	fire detection and suppression land navigation systems laser detectors laser rangefinders smoke dischargers, grenades and decoys	213 421 204 459 193	LV5 laser rangefinder LV350 series laser rangefinders LV400 series laser rangefinders LWD 21 Helio Laser Warning System	46 46 46
HOT Euromissile HRLR High Repetition Laser Rangefinder and HRLR-ES High Repetition Laser Rangefinder-Eye Safe HSWL 106 transmission HSWL 194 transmission HSWL 284 transmission HSWL 354 transmission	55 . 459 . 234 . 232 . 232 . 233	fire detection and suppression land navigation systems laser detectors laser rangefinders smoke dischargers, grenades and decoys suspensions	213 421 204 459 193 281	LV5 laser rangefinder LV350 series laser rangefinders LV400 series laser rangefinders LWD 21 Helio Laser Warning System LWD 21 Laser Warning Device	46 46 20 20
HOT Euromissile HRLR High Repetition Laser Rangefinder and HRLR-ES High Repetition Laser Rangefinder-Eye Safe HSWL 106 transmission HSWL 194 transmission HSWL 284 transmission HSWL 354 transmission HSWL 354 transmission	55 . 459 . 234 . 232 . 232 . 233 87	fire detection and suppression land navigation systems laser detectors laser rangefinders smoke dischargers, grenades and decoys suspensions tracks	213 421 204 459 193 281 272	LV5 laser rangefinder LV350 series laser rangefinders LV400 series laser rangefinders LWD 21 Helio Laser Warning System LWD 21 Laser Warning Device LWMS Lightweight Modular Thermal Sight	46 46 20 20 54
HOT Euromissile HRLR High Repetition Laser Rangefinder and HRLR-ES High Repetition Laser Rangefinder-Eye Safe HSWL 106 transmission HSWL 194 transmission HSWL 284 transmission HSWL 354 transmission HSWL 354 transmission Hackman cartridge cases Hägglunds Vehicle 20 mm gun turret Rh 202	55 .459 .234 .232 .232 .233 87 .337	fire detection and suppression land navigation systems laser detectors laser rangefinders smoke dischargers, grenades and decoys suspensions tracks vehicle-mounted anti-tank guided weapons	213 421 204 459 193 281 272 57	LV5 laser rangefinder LV350 series laser rangefinders LV400 series laser rangefinders LWD 21 Helio Laser Warning System LWD 21 Laser Warning Device LWMS Lightweight Modular Thermal Sight LWS-2 laser warning system	46 46 20 20 54
HOT Euromissile HRLR High Repetition Laser Rangefinder and HRLR-ES High Repetition Laser Rangefinder-Eye Safe HSWL 106 transmission HSWL 194 transmission HSWL 284 transmission HSWL 354 transmission Hackman cartridge cases Hägglunds Vehicle 20 mm gun turret Rh 202 Hägglunds Vehicle 20 mm turret HS 804	55 .459 .234 .232 .232 .233 87 .337	fire detection and suppression land navigation systems laser detectors laser rangefinders smoke dischargers, grenades and decoys suspensions tracks vehicle-mounted anti-tank guided weapons weapon control and stabilisation systems	213 421 204 459 193 281 272 57 366	LV5 laser rangefinder LV350 series laser rangefinders LV400 series laser rangefinders LWD 21 Helio Laser Warning System LWD 21 Laser Warning Device LWMS Lightweight Modular Thermal Sight LWS-2 laser warning system Lancelot HOT turret	46 46 20 20 54 20
HOT Euromissile HRLR High Repetition Laser Rangefinder and HRLR-ES High Repetition Laser Rangefinder-Eye Safe HSWL 106 transmission HSWL 194 transmission HSWL 284 transmission HSWL 354 transmission HSWL 364 transmission HSWL 364 transmission HSWL 364 transmission Hackman cartridge cases Hägglunds Vehicle 20 mm gun turret Rh 202	55 .459 .234 .232 .232 .233 87 .337 .337	fire detection and suppression land navigation systems laser detectors laser rangefinders smoke dischargers, grenades and decoys suspensions tracks vehicle-mounted anti-tank guided weapons	213 421 204 459 193 281 272 57 366	LV5 laser rangefinder LV350 series laser rangefinders LV400 series laser rangefinders LWD 21 Helio Laser Warning System LWD 21 Laser Warning Device LWMS Lightweight Modular Thermal Sight LWS-2 laser warning system	46: 46: 20: 20: 54: 20: 31: 42

Lansadot family of armoured vehicle fire-control	205	Marconi MOGUL Modular Gun Laying system		NobelTech Electronics AB integrated tank fire-control	102
Laser irradiation detector (Yugoslav)	395 212	Marconi PD700 light armoured vehicle dual axis power drive system		system Type FV	403
Laser weapon programmes (USA)	40	Marconi series 1220 laser warning receiver	209	sight	509
Leica BIG2 commander's night vision goggles	510 447	Marder 1 turret		NobelTech Universal Tank and Anti-Aircraft Systems –	101
Leica NAP5 night driving periscope Leica SRZ/SKS muzzle boresight		Marotta automatic explosion suppression system Martin Marietta ammunition		UTAAS North American Dynamics M113 universal gun	404
Leitz daylight/thermal imaging alignment collimator		Martin Marietta composite armour		mount	
KTW 18mLeitz GPG-20 20 mm synchroniser test device		Martin Marietta Copperhead 155 mm Cannon-	1.4.4	North Finding Module (NFM)	424
Leitz MODUS-P optronic panoramic periscope		Launched Guided Projectile (CLGP)	. 144	AFV turrets and cupolas	331
Linamar Group TOW-Armoured Launching Turret		mount		ammunition	113
(ALT)		Matador family of tank fire-control systems		driver day and night vision systems	
Litton M-912A/M-915A night vision goggles Litton M-972/M-973 night vision goggles		Mauser MK 25 mm x 137 Model E cannon Mauser MK 30 mm x 173 Model F (MK30) cannon		laser detectors	
Litton TK-640 laser rangefinder	469	Mécanique Creusot-Loire add-on armour kits	170	smoke dischargers, grenades and decoys	195
Loral gunner's day/night thermal Tank Periscope Sight		Mécanique Creusot-Loire CB 60 HB shield gun racer fo		weapon control and stabilisation systems	
(TPS)		60 mm mortar Mécanique Creusot-Loire CB 127 VE shield gun racer	. 302	Nova general-purpose night vision goggles	448
Loral International Thermal Sight (ITS)		for 12.7 mm machine gun	307		
Loral Vought Systems Hypervelocity (HVM)		Mécanique Creusot-Loire CB shield gun racer for		0	
Programme Lotus Engineering active suspension system		7.62 mm machine gun Mécanique Creusot-Loire CP 127 A pivot gun racer		OB-31 night driving periscope	438
Lucky-Goldstar International Corporation track shoes		Mécanique Creusot-Loire Leclerc automatic loader for		OB-41 night driving binoculars	
Lynx 90 turret	299	Leclerc MBT		OB-47 tank gunner's night sight	
		Mécanique Creusot-Loire P 127 A pivot mount Mécanique Creusot-Loire STB V shield rotary mount		OB-60 day/night driver's periscope OG 14 L2B tank laser fire-control system	
M		Mécanique Creusot-Loire STBE shield rotary mount		OG-P20 periscope sight	
		Mécanique Creusot-Loire STR rail-mounted rotary		OG-P101 periscope sight	
M1 Abrams Thermal Imaging System (TIS)		mount		OG-PO7 periscope sight	
M1 MBT laser rangefinder	400	rotary mount		OTO Melara 60 high-velocity gun system OTO Melara 105 low recoil force gun	
Subsystem	531	Mécanique Creusot-Loire T.20 turret	. 304	OTO Melara 120 smooth-bore gun	22
M19A1 driver's night periscope		Mecanique Creusot-Loire T.25 turret	. 303	OTO Melara SIDAM 25 anti-aircraft turret	
M32E1 tank gunner's periscope		Mécanique Creusot-Loire TLi 52 A machine gun turret	310	OTO Melara T 60/70 A turretOTO Melara T 90 CKL turret	
M36-SIRE gunner's sight integrated ranging	000	Mécanique Creusot-Loire TLi 127 close defence		OTO Melara TC 20 turret	
equipment		cupola	. 306	OTO Melara TPT Mk 4 12.7 mm turret	329
M36E1 day/night tank periscope		Mécanique Creusot-Loire TLiG series of machine gun turrets	300	OTO Melara/BREDA T 25 turret Oerlikon-Contraves 20 mm Type KAA cannon	
M41 repower package		Mécanique Creusot-Loire TOI observation and	. 303	Oerlikon-Contraves 25 mm automatic cannon Type	30
M48H advanced fire-control system	405	intervention cupola	307	KBA	
M76 infra-red smoke grenade		Menachem Urman Centurion tank commander's cupola	224	Oerlikon-Contraves 25 mm Type KBB-cannon Oerlikon-Contraves 30 mm Type KCB cannon	
M105 series gunner's articulated sighting telescopes		Mephisto HOT system		Oerlikon-Contraves 35 mm cannon Type KD series	
M113 diesel conversion	220	Messier suspension systems	278	Oerlikon-Contraves ammunition	130
M113 technology demonstrator, SCG		Miller-Holzwarth armoured vehicle periscopes		Officine Galileo Madis sighting and drive system	
M371 episcopic sight		Minor Calibre Weapons Station Mithridat fire-control system		Officine Galileo OG-P20 periscope sight	
M-912A/M-915A night vision goggles		Model 220 fire control sight	532	Officine Galileo OG-PO7 periscope sight	
M-972/M-973 night vision goggles		Model 317 night vision kit for M20 sight		Officine Galileo Thetis thermal tank infra-red	400
MAPS/GPS Modular Azimuth Positioning System with Global Positioning System		Model 910 integrated sight		system Officine Galileo vehicle commander's SP-T-694	498
MBT G360 20 mm multi-purpose light cannon	22	Model 939 gunner's auxilliary sight		gyrostabilised panoramic day/night sight	497
MECAR 90/28 mm light gun system		Model 957 squad leader's search periscope		Officine Galileo VIR52 gunner's night vision	407
MECAR Improvement Programme for 90 mm Cockerill		Model 998 fire control backup sight Model 1500 (AN/PVS-7B) night vision goggles		periscopeOldelft HNV-1 holographic goggles	
Mk III and 90 mm ENGESA EC- 90 guns		Model 9265 Vehicle Navigation Aid System (VNAS)		Oldelft Lightweight Universal Night Observation	100
MES VG/DIL 186 day and night driver scope system	. 442	Model 9876C (AN/PVS-5C) night vision goggles		System (LUNOS)	443
MFS engine compartment fire extinguishing system MILAN Compact Turret (MCT)		Moked Third Eye laser warning system		Oldelft Low Light Level Television System Type GS6TV	501
MILAN Euromissile		Moto Pecas gunner's shield for M113 commander's	270	Oldelft LRS 5 fire-control system	
MILNAV Miniature Integrated Land Navigation		cupola		Oldelft LRS 7 fire-control system	
System	203	Moto Pecas M113 diesel conversion	220	Oldelft Mk 2 thermal observation and aiming sight for infantry fighting vehicles	. 500
Mk 2 thermal observation and aiming sight for infantry				Oldelft Mk 3 thermal observation and aiming system	000
fighting vehicles		N		for MBTs	
Mk 3 thermal observation and aiming system for MBTs	501	NA-10 Eland night sight adaptor	505	Oldelft RSI tank laser rangefinder Oldelft TILAS tank laser sight	
MK 25 Model E 25 mm vehicle-mounted turret		NA-70 Eland riight sight adaptor		Oldelft Type LAT laser rangefinder for tanks	
MKEK ammunition		NANOQUEST L20 series sight laser rangefinders		Oldelft Type PC1MC Cyclop night vision goggles	
ML Aviation 'T' tank gunner's telescopic laser rangefinder sight	467	NANOQUEST L50 series sight laser rangefinders NAP5 night driving periscope		Oldelft Type PG1MS night vision goggles Oldelft Type TS7TS gunner's passive aiming sight	
MMC V-150 Commando repower kit		NAPCO International retrofit power packages		Olin 20 mm ammunition	
MODUS-P optronic panoramic periscope	. 486	NATO future 140 mm tank gun	20	Olin Ordnance ammunition	. 146
MOGUL Modular Gun Laying system		NAV 1000 M5 Global Positioning System (GPS) NAVYX position determining system		Optic Electronic AN/VVG-2 commander's integrated laser rangefinder	170
MP86 multi-purpose gunner's periscope		ND-15 night driverscope		Optic Electronic driver's night viewers family	
MPATS	57	ND-20 night driver's periscope	445	Optic Electronic E*GLE laser rangefinder kit	
MSZ-2 gunner's day/night periscope		NDS-2 passive driver's night vision viewer		Optic-Electronic GNP 55 gunner's night vision	E 20
MTL-8 modular laser rangefinder	400	NE-20 night elbow		periscope Optic-Electronic gunner's sight integrated ranging	. 550
GmbH		NFT electric drive systems for gun turrets	367	equipment M36-SIRE	
MTU powerpacks		NICO Pyrotechnik vehicle grenades		Optic-Electronic M26 muzzle boresight Optic-Electronic M32E1 tank gunner's periscope	
MV103 series digital fluxgate compasses MX7120 with remote control display unit		NIMDA retrofit powerpacks NITE LITE target acquisition system		Optic-Electronic M35E1 tank gunner's periscope	
Maasara ammunition		NKA 55 North-seeking gyro system		Optic-Electronic M36E1 day/night tank periscope	
McDonnell Douglas 25 mm M242 Bushmaster cannon	10	NORINCO ISFCS-212 Image Stabilised tank Fire- Control System	202	Optic-Electronic M105 series gunner's articulated sighting telescopes	For
McDonnell Douglas 30 mm ASP-30 combat support	40	NORINCO Red Arrow 8		Optic-Electronic MP86 multi-purpose gunner's	, 557
weapon	45	NORINCO Type 79-II tank gunner's sight	472	periscope	
McDonnell Douglas 30 mm Bushmaster II automatic	AF	NORINCO Type 1985 passive night vision goggles		Optic-Electronic muzzle reference collimator	
McDonnell Douglas 30 mm M230 Chain Gun	45	NORINCO Type 12150L diesel engine NORINCO Type TDPN-2 driver's night viewer		Optic Electronic NV38 driver's viewer Optic Electronic NV43FL driver's night and emergency	
automatic cannon	44	NORINCO X150-960 diesel engine	221	day/NBC viewer	
McDonnell Douglas 35 mm/50 mm Bushmaster III	40	NSM 20 land navigation system		Optic-Electronic NV46S commander's passive night vision periscope	E20
automatic cannon	43	NV38 driver's viewer NV40 gunner's passive night vision periscope		Optic-Electronic NV52 day/night vision periscope	
cannon		NV43FL driver's night and emergency day/NBC		Optic-Electronic US Army standard passive night vision	n
Madis sighting and drive system	499	NV 46 compander's passive pight vising parisages		elbow	
Magellan NAV 1000 M5 Global Positioning System (GPS)	433	NV 46 commander's passive night vision periscope NV46S commander's passive night vision periscope		Osprey combined day/night laser sight	. 524
Magnavox GPS Engine™ turbo version	434	NV52 day/night vision periscope	539		
Magnavox MX7120 with remote control display unit		NV(L) 3001 day/night laser rangefinder sight family .	512	P	
Malaysia AFV engines, transmissions and powerpacks	240	NWM De Kruithoorn ammunition Netherlands	112	P40 transmission	251
Mangouste 60 mm/12.7 mm turret		AFV engines, transmissions and powerpacks	240	P170L and P240L day/night gunner's laser	
Marconi Centaur tank weapon control system	405	ammunition	110	periscopes	
Marconi Digital Fire-Control System Marconi GCE 628 gun control and stabilisation	406	day and night sighting systemsdriver day and night vision systems		P186 gunner's telescopic sight	
equipment	372	laser rangefinders		P204 day/night gunner's periscope	
Marconi gunner's Thermal Imaging Vehicle Sight		suspensions		P223 vehicle commander's night vision periscope	49
(TIVS)		Night Vision Equipment Company NVEC 800/NVEC 800 HP night vision goggles	451	P 127 A pivot mount	
Joseph monoment with 30 mm and alleran turiet	- W. T.	and responsible and a second se			

PCE 21 G 15 gunner's weapon control station		Rh 202		SIG brushless 24 V DC electrical gun control and stabilisation system	260
PCN night driving periscope series PD700 light armoured vehicle dual axis power drive	440	Rheinmetall 20 mm TS-15 turret family		SIG electrohydraulic gun control system	
system	372	Rheinmetall 20 mm turret TF 20 15. A	318	SIG T-54/55 gun control retrofit kit	
PEO driver's night vision goggles		Rheinmetall 105 mm tank gun family		SIG universal control handles 3	370
PEO driver's passive night vision periscope		Rheinmetall 120 mm under armour mortar system		SIGNAAL Usfa UA9630 driver's universal passive	1113
PEO tank fire-control systems PERI-R17A1 panoramic periscope with automatically	401	Rheinmetall 140 mm smooth-bore gun		periscope series SIGNAAL Usfa UA 9124/9126 day/night periscope	+42
stabilised line-of-sight	486	Rheinmetall automatic cannon MK 35/50 mm Rh 503		sight system	502
PERI-R17TW gyrostabilised panoramic periscope with		Rheinmetall TS-7 20 mm turret		SIGNAAL Usfa UP1011 and UP1001 day/night aiming	
day and thermal channels		Rheinmetall twin 7.62 mm machine gun turret TUR-1 .		and observation systems	
PERI-RF gyrostabilised panoramic periscope PERI-ZL gunner's gyrostabilised observation and	487	Rockwell Hellfire modular missile system Rockwell Multi-sensor Target Acquisition System		SIMRAD GN1 night vision goggles	
sighting periscope with integrated laser rangefinder	487	Rockwell Small, Low-cost Interceptor Device (SLID)		SIMRAD LV5 laser rangefinder	
PHOTONIC FSC-530 fire-control system for recoiless	. 407	Roller Chain Band track		SIMRAD LV350 series laser rangefinders	
guns	376	Romania		SIMRAD LV400 series laser rangefinders	
PN-2 passive night vision goggles	455	ammunition		SIMRAD RL 1 laser warning receiver	
PNU Position Navigation Unit for multiple rocket		laser detectors	206	SLID Small, Low-cost Interceptor Device	
launcher system		Rotary Power International Stratified Charge	250	SMArt 155 mm projectile	
POLUX light optronic processorPOS-NAV Position Navigation System		Omnivorous Rotary Engine (SCORE)		SNC Industrial Technologies Inc ammunition SNPE combustible cartridge cases	
PP-01 aiming periscope		Royal Ordnance 76 mm L23A1 gun		SNPE insensitive material for explosive reactive	
PP-02 observation and aiming periscope		Royal Ordnance 105 mm Improved Weapon System		armour	169
PPV-2 passive night vision periscope		Royal Ordnance 105 mm L7 tank gun series		SOPELEM CN2-500 passive driving periscope series	
PYRKAL ammunition	. 100	Royal Ordnance 105 mm low recoil force gun	33	SOPELEM ESTER 10 laser rangefinder for AFVs	457
PYRKAL GRL-76-10 76 mm tank close defence	100	Royal Ordnance 105 mm T-54, T-55 and Type 59 gun	0.4	SOPELEM HL 33 daylight panoramic observation	400
system Pacific Scientific HTL/Kin-Tech Division Automatic Fire		Royal Ordnance 115 mm tank gun barrel		telescope SOPELEM M371 episcopic sight	
Extinguishing Systems (AFES)		Royal Ordnance 120 mm armoured mortar system		SOPELEM 08-47 tank gunner's night sight	
Pakistan	. 2 10	Royal Ordnance 120 mm L11 tank gun		SOPELEM SOPTAA 19 fire-control system	
AFV turrets and cupolas	. 332	Royal Ordnance 120 mm L30 tank gun		SOPELEM SOPTAC 11 fire-control system	
ammunition		Royal Ordnance ammunition		SOPELEM SOPTAC 18 fire-control system	
driver day and night vision systems		Royal Ordnance Electro Thermal Chemical guns		SOPELEM SOPTAC 36 fire-control system	
Pakistan Ordnance Factories ammunition	. 114	Royal Ordnance L8 smoke grenades		SOPELEM SOPTAM fire-control system	
Pakistan Ordnance Factories twin 106 mm recoilless rifle mount	333	Royal Ordnance ROMOR appliqué armour systems	1/9	SOPELEM TELAB laser rangefinder	
Panhard AML upgrade kit		Royal Ordnance visual and Infra-red smoke screening system	199	SOPELEM TJN2-71 day/night optical sight	
Passive AFV protection system (CIS)		Rudi Cajavec SUV-T55A tank fire-control system		SOPELEM TN2-1 Hight vision billoculars	.00
Passive armour, CIS	167	Ruggieri Spider close-in vehicle defence system		armoured vehicles	
Peak 66 mm grenade dischargers	. 198			SOPTAC 11 IR control system	
Perkins 100 series diesel engines				SP1/127 weapon station	
Perkins Condor diesel engines				SP2/300 weapon station	
Perkins Eagle Tx diesel engine Perkins Phaser diesel engines		S		SP3/300 weapon station SP-T-694 vehicle commander's gyrostabilised	292
Perkins powerpacks		SABBLIC passive armour	176	panoramic day/night sight	497
Perkins T6.3544 diesel engine		SABCA ATLAS family advanced tank laser fire control	11.0	SRP/PDS Stabilisation Reference Package/Position	10.000
Philips BM8025 night aiming and observation		systems	376	Determining System	
system	484	SABCA Thermal Imaging Sight (TIS) system for		SRZ/SKS muzzle boresight	
Pilkington Optronics Condor commander's day/night		Leopard 1 MBT		SS100/SS110 night sights	
sighting system Pilkington Optronics Nova general-purpose night vision		SABCA Titan family tank fire-control systems SABCA Universal tank fire-control system		SS120 commander's night sight	
gogglesgoggles		SACM diesel UDX range of military engines		SS130 passive night driving periscope	
Pilkington Optronics Osprey combined day/night laser		SADARM Sense And Destroy Armor Munition		SS141, SS142 commander's night and SS162	77.7
sight		SAGEM CITA 20 navigator and inertial goniometer		commander's day vision periscopes	518
Pilkington Optronics passive night vision driving		SAGEM DANAOS Day And Night Artillery Observer		SS180 armoured vehicle day/night sight	
periscope		System		SS500 series armoured vehicle thermal sights	
Pilkington Optronics Raven combined day/night sight	523	SAGEM M389 commander's panoramic sight		STAFF 120 mm Smart Target Activated Fire-and-Forget	
Pilkington Optronics Sabre day and day/night vehicle sights	E24	SAGEM NSM 20 land navigation systemSAGEM SIGMA 30 ring laser gyro inertial navigation	414	120 mm tank round XM943 STBE shield rotary mount	
Pilkington Optronics systems for Challenger 2 MBT		system	415	STB V shield rotary mount	
Placencia CD-850 transmission production		SAGEM Stabilised Aiming, Vertical Sensing and		STR rail-mounted rotary mount	
Placencia ammunition		Navigation (SAVAN) gunner's multi-channel stabilised		STRTA all-round rail-mounted rotary mount	
Poland		sight		SUV-84 tank fire-control system	
AFV engines, transmissions and powerpacks	. 240	SAGEM ULISS 30 Position and Azimuth Determination		SUV-T55A tank fire-control system	
AFV fire control systems	. 401	System (PADS)	415	SYDADE land navigation system	
armour systemsdriver day and night vision systems		SAGEM VIGY 40 commander's modular stabilised panoramic sight	473	Sabre day and day/night vehicle sights	
Poongsan Metal Corporation ammunition		SAKO ammunition		Saco Defense 40 mm Mk 19 Mod 3 machine gun	
Portugal		SAMM BTM family of light turrets		system	4:
AFV engines, transmissions and powerpacks		SAMM CE 10 electric turret drive system		Santa Barbara Research Center explosion/fire	
ammunition	115	SAMM CE 15 electric turret drive system		protection system	
Positioning and Azimuth Determining System (PADS)	100	SAMM CE 24 electric turret drive system		Santa Barbara Research Center laser warning sensor	
Mk 2 Protection of US armoured vehicles		SAMM CE 40 electric turret drive system		Saviour laser warning system	
Protective Materials Company M113 spall suppressar		SAMM PCE 21 G 15 gunner's weapon control station		Sekur track links	
armour system		SAMM suspension systems		Self-Changing Gears M113 technology demonstrator	
Puma cupola		SAMM TAB 220 20 mm anti-aicraft turret	306	Sense And Destroy Armor Munition (SADARM)	14
		SAMM TTB 190 90 mm turret	298	Serval 60/20 turret	30
D		SANTA BARBARA 40 mm SB40 LAG automatic	20	Sextant Avionique ARVERNE (APX M539) magnetic	A 1
R		grenade launcher SANTA BARBARA ammunition		heading indicator system Sextant Avionique NAVYX position determining	+1.
RAFAEL NITE LITE target acquisition system	. 491	SANTA BARBARA armidificition		system	41
RAFAEL Overhead Weapon Station	323	SANTA BARBARA SABBLIC passive armour	176	Sextant Avionique SYDADE land navigation system	41
RAFAEL periscopic viewing sight	492	SANTA BARBARA TC-3 (A-1) 12.7 mm turret	. 332	Sextant Avionique TMV 565 monochrome TV	
RAFAEL screen obscurant smoke system		SANTA BARBARA TC-9/OP and TC-17/CL turrets		micromonitor	
RAFAEL upgrading of combat vehicles		SANTA BARBARA TC-13/M242 turret		Shtora 1 AFV defence system	
RAFCOM-1 heading reference systemRAMTA improved TOW/MAPATS vehicle		SANTA BARBARA TC-25/M242 turretSAT/Thomson-TRT Defense Athos thermal imaging	. 334	Siemens Type LEM 3 laser rangefinder	
RAPHAEL Toga add-on passive armour		system	481	Singapore	1.60
RARDEN 30 mm ammunition		SCG T300 and T320 transmission		AFV engines, transmissions and powerpacks	24
RARDEN APDS ammunition	140	SCG TN12 transmission	253	ammunition	.11
RARDEN L21 30 mm gun		SCG TN15 transmission		day and night sighting systems	
RAUFOSS instantaneous ample sergering systems		SCG TN26 transmission		Singapore Automotive Engineering services	
RAUFOSS instantaneous smoke screening systems RDM AFV retrofit packages		SCORE Stratified Charge Omnivorous Rotary Engine SCT ceramic armour		Sirius daytime thermal panoramic stabilised sight	4/
REMIE SpA ammunition		SESM transmissions		AFV fire control systems	40
RK 304 transmission		SFAW/SIG flick rammer		day and night sighting systems	
RL 1 laser warning receiver	205	SFIM HL-70 commander's gyrostabilised panoramic		laser detectors	. 20
RLNS Ring Laser Gyro Land Navigation System	431	sight	477	laser rangefinders	
ROMOR appliqué armour systems		SFIM SILVER strapdown Attitude and Heading	4	Smiths Industries Model 9265 Vehicle Navigation Aid	
RSI tank laser rangefinder		Reference System (AHRS)		System (VNAS)	. 43
Racal Saviour laser warning system		SFIM SILVERNAV land navigation system SFIM Sirius daytime thermal panoramic stabilised	416	Smiths Industries POS-NAV Position Navigation System	12
Red Tiger tank fire-control system		sight	476	Sociedade Portuguesa de Explosivos ammunition	
Renault engines		SFIM VISAA stabilised anti-aircraft sight		Soltam 120 mm under armour mortar	
Renault Transfluide transmission		SFIM VS 580-30 gyrostabilised thermal sight		Soltam ammunition	
Renk HSWL 106 transmission	234	SFIM VS family of gyrostabilised sights	. 475	South Africa	
Renk HSWL 194 transmission		SG-55A tank commander's gyrostabilised sight		addenda	
Renk HSWL 284 transmission		SGTS Second Generation Tank Sight		AFV fire control systems	
Renk HSWL 354 transmission Renk RK 304 transmission		SHL hydraulic bumpers SHL turret system upgrade packages		ammunition	
Renk tank transmissions, other		SIDAM 25 anti-aircraft turret		driver day and night vision systems	
Renk transmissions for heavy wheeled vehicles		SIG all-electric turret drive and gun laying system with		land navigation systems	42
Rheinmetall 20 mm automatic cannon MK 20		digital AC servos (dACs) and brushless technology	370	laser rangefinders	46

smoke dischargers, grenades and decoysvehicle-mounted anti-tank guided weapons		Sight	526	U	
weapon control and stabilisation systems		TPT Mk 4 12.7 mm turret		UA 9124/9126 day/night periscope sight system	502
weapons of 20 mm and upward		TS-7 20 mm turret	317	UA9630 driver's universal passive periscope series	
Spain		TS-15 20 mm turret family		UDX range of military engines	
AFV engines, transmissions and powerpacks	103	TS-30 thermal elbow		UGO observation and driving gogglesULISS 30 Position and Azimuth Determination System	
AFV turrets and cupolas		TTB 190 90 mm turret		(PADS)	
ammunition	121	TTS laser rangefinder	470	UP1011 and UP1001 day/night aiming and	
armour systems		TTS Tank Thermal Sensor		observation systems	
day and night sighting systems		TUA TOW Under Armour turret TUR-1 twin 7.62 mm machine gun turret		US appliqué armour programmes	. 183
driver day and night vision systems	26	TURMS laser tank fire-control system		US Army ETC and gun propulsion process development	39
Spectronix Automatic Fire and Explosion Detection and		Taiwan	000	US Army explosive reactive armour programmes	
Suppression System (AFEDSS)		AFV fire control systems		US Army standard passive night vision elbow	
Spider close-in vehicle defence system		ammunition		USSR, former	
Steelcore Heavy Equipment armour systems		Talley Defense Systems extended range ammunition		coaxial machine guns	
Steyr SP1/127 weapon station Steyr SP2/300 weapon station	293	Tank ammunition (CIS) Teldix FNA 50 vehicle navigation system		UTAAS Universal Tank and Anti-Aircraft Systems UTM 800 HOT turret	
Steyr SP3/300 weapon station		Teldix FNA 55 vehicle navigation system		UWS 40 mm/12.7 mm Upgunned Weapons Station	
Stillbrew passive armour system		Teldix NKA 55 North-seeking gyro system		United Kingdom	
Sweden		Teldix vehicle navigation systems		addenda	
AFV fire control systems		Teldix FOA 25 FOA 50 vehicle orientation systems		AFV engines, transmissions and powerpacks	
AFV turrets and cupolas		Teledyne Continental Motors diesel engines		AFV fire control systems	
ammunitionarmour systems		Teledyne external suspension systems Telefunken Systemtechnik electrical weapon control	289	AFV turrets and cupolas	
day and night sighting systems	509	and stabilisation systems	364	armour systems	
smoke dischargers, grenades and decoys		Telefunken Systemtechnik LLLTV aiming and		automatic loaders and flick rammers	
vehicle-mounted anti-tank guided weapons	59	observation system with IR scanner		coaxial machine guns	
weapons of 20 mm and upward			488	day and night sighting systems	
Swingfire	60	Texas Instruments AN/VSG-2 Tank Thermal Sight	E40	driver day and night vision systems	
Switzerland ammunition	130	(TTS) Texas Instruments Avenger laser rangefinder		fire detection and suppressionland navigation systems	
automatic loaders and flick rammers		Texas Instruments Combat Vehicle Thermal Targeting	47,	laser detectors	
coaxial machine guns		System (CVTTS)	543	laser rangefinders	. 466
day and night sighting systems	510	Texas Instruments Extended Range Gunnery Fire-		smoke dischargers, grenades and decoys	. 197
driver day and night vision systems		Control Demonstration System (ERGFCDS)	407	suspensions	
weapon control and stabilisation systems		Texas Instruments Full-Solution Tank Fire-Control System	400	tracks	
weapons of 20 mm and upward	26	Texas Instruments Gunner's Primary Tank Thermal	400	vehicle-mounted anti-tank guided weapons weapon control and stabilisation systems	
		Sight (GPTTS)	543	weapons of 20 mm and upward	
		Texas Instruments improved M60A3 fire-control		United Scientific gun control equipment for T-series	
T		system		MBTs	372
	0.40	Texas Instruments Light Armoured Vehicle-Air Defense		United States of America	540
T6.3544 diesel engine T.20 turret		(LAV-AD) primary sight system Texas Instruments Lightweight Modular Thermal Sight		AFV engines, transmissions and powerpacks	
T.25 turret	303	(LWMS)		AFV fire control systems	
T 25 turret	327	Texas Instruments Modular Target Acquisition System	0.10	AFV turrets and cupola	
T25 25 mm low-profile turret		(MTAS)	408	ammunition	
T-54, T-55 and T-62 MBT fire-control systems		Texas Instruments tank commander's independent		armour systems	
T 60/70 A turret	327	thermal viewer	542	automatic loaders and flick rammers	
T-64, T-72 and T-80 MBT fire-control systems T-72 MBT which is armed with a 125 mm D-81TM	. 383	Texas Instruments Thermal Imaging Multisensor System	408	coaxial machine gunsday and night sighting systems	
(2A46) smooth-bore gun 120 mm (2A60) breach-		Texas Instruments TTS laser rangefinder		driver day and night vision systems	
loaded mortar	4	Textron Lycoming AGT 1500 gas turbine		fire detection and suppression	
T 90 CKL turret		Thermal Imaging Multisensor System	408	land navigation systems	
T300 and T320 transmission		Thermal Imaging Sight (TIS) system for Leopard 1		laser detectors	
T tank gunner's telescopic laser rangefinder sight	. 467	MBT		laser rangefinders	
TAAS – Israel Industries 60 mm Hyper-Velocity Medium Support weapon (HVMS 60)	21	Thetis thermal tank infra-red system Thiokol ammunition		smoke dischargers, grenades and decoyssuspensions	
TAAS – Israel Industries 120 mm smooth-bore tank	2 1	Third Eye laser warning system		tracks	
gun	21	Thomson Brandt 60 mm MCB 60 C gun mortar		vehicle-mounted anti-tank guided weapons	
TAAS - Israel Industries 140 mm smooth-bore gun	21	Thomson Brandt 60 mm MCB 60 LR gun mortar		weapon control and stabilisation systems	
TAAS – Israel Industries CL-3030 instantaneous self-		Thomson Brandt 81 mm MCB gun mortar		weapons of 20 mm and upward	
screening system for combat vehicles	. 194	Thomson Brandt Armements ammunition Thomson-CSF Camille fire control radar		United States Artillery Fired Atomic Projectiles (AFAP)	
TAAS - Israel Industries MPATS		Thomson-CSF MIRIADE radar warning receiver		United States electric drive developments	
TAAS - Pedestal Operated Multi-Ammunition		Thomson-TRT Défense Castor thermal imaging system		United States tank automatic loader developments	
Launching System (POMALS)		for armoured vehicles	. 483	Urdan Industries commander's cupola for M88A1	
TAB 220 20 mm anti-aicraft turret		Thomson-TRT Défense CT-30 thermal fire control		ARV	
TAMAN Directional Gyro Indicator (DGI)	. 424	system	. 482	Urdan Industries low-profile commander's cupola Urdan M113 add-on armour kit	
TAMAN Guns Orientation and Navigation System (GONS)	423	system	482	Urdan track shoes	
TAMAN Land Navigation System - Mark I	. 420	Thomson-TRT Défense OB-31 night driving	. 402	Citali track Silocs	4/4
(LANS Mk I)	. 421	periscope	438		
TAMAN Land Navigation System - Mark II (LANS Mk	00120-00	Thomson-TRT Défense OB-41 night driving		987	
TAMAAN Land Navigation System Made NV/LANS All	. 422	binoculars	. 438	V	
TAMAN Land Navigation System - Mark IV (LANS Mk IV)	122	Thomson-TRT Défense OB-60 day/night driver's periscope	139	V-150 Commando repower kit	240
TAMAN North Finding Module (NFM)		Thomson-TRT Défense POLUX light optronic		V 200 vision block	
TAMAN Vehicle Navigation System (VNAS)		processor	. 482	VARMA armour systems	
TC-3 (A-1) 12.7 mm turret		Thomson-TRT Défense UGO observation and driving		VCTIS Vehicle Command and Tactical Information	
TC-9/OP and TC-17/CL turrets		goggles		System	
TC-13/M242 turret		Thyssen Henschel M113 supplementary armour kit Titan family tank fire-control systems		VG/DIL 186 day and night driver scope system VIR52 gunner's night vision periscope	
TC-25/M242 turret		Toga add-on passive armour		VISAA stabilised anti-aircraft sight	
TCM 105 mm Low-Profile Turret (LPT)		Toucan I turret	. 305	VS 580-30 gyrostabilised thermal sight	475
TCV107 laser rangefinder		Toucan II turret		VS family of gyrostabilised sights	
TCY901 laser rangefinder		Tracor Aerospace advanced countermeasure dispense		VSEL GBT 155 155 mm gun turret	
TE-20 TV camera adaptor TELAB laser rangefinder		system Tracor Aerospace advanced smoke launcher system _		Vammas gun systems	87
TF 20 15 20 mm turret		Turkey		gogglesgoggles	454
TF 20 15. A 20 mm turret	318	ammunition		Varo Model 1500 (AN/PVS-7B) night vision goggles .	454
TILAS tank laser sight		Type 79-II tank gunner's sight		Vehicle Integrated Defense System (VIDS)	
TISH IR26 Thermal Imaging Sensor Head		Type 82 tank laser rangefinder		Vehicle Navigation System (VNAS) Vickers Defence Systems dynamic track tensioning	423
TIVS gunner's Thermal Imaging Vehicle Sight		Type 90 MBT Fire-Control System (FCS) Type 270/M239 66 mm smoke grenade launcher		system	287
TK-640 laser rangefinder		Type 453 laser warning receiver		Vickers Defence Systems hydraulic track tensioner	
TLi 52 A machine gun turret		Type 605 12.7 mm turret		Vickers Defence Systems Stillbrew passive armour	
TLi 127 close defence cupola	306	Type 629 lightweight modular laser rangefinder	466	system	
TLIG series of machine gun turrets		Type 1985 passive night vision goggles		Vickers Defence Systems VARMA armour systems	
TLMD-3 tank laser rangefinder		Type 2365 gun mount		Vickers Warrior 30 mm turret	
TMC 81 mm gun-mortar turret		Type 2706 machine gun mount Type 12150L diesel engine		Vista Controls M109 robot: pneumatic rammer	08
TMS301 Eyesafe laser rangefinder		Type FV day/night gunner's sight			
TMV 565 monochrome TV micromonitor	478	Type FV integrated tank fire-control system			
TN2-1 night vision binoculars	438	Type GS6TV low light level television system	501	w	
TN12 transmission		Type LAT laser rangefinder for tanks		WPC V desired at 1 constant	400
TN15 transmission		Type LEM 3 laser rangefinder		WBG-X thermal sight for armoured vehicles WP-7 under armour overhead weapon post	
TN26 transmission		Type MZA 1865 machine gun mount Type PC1MC Cyclop night vision goggles		WSLI Warning System on Laser Illumination	
TN54 transmission		Type PG1MS night vision goggles		Warning System on Laser Illumination (WSLI)	
TNA-4 Tank navigation Apparatus	412	Type TDPN-2 driver's night viewer	436	Warrior 30 mm turret	341
TOI observation and intervention cupola	307	Type TS7TS gunner's passive aiming sight	500	Wegmann 76 mm adjustable launcher system	191

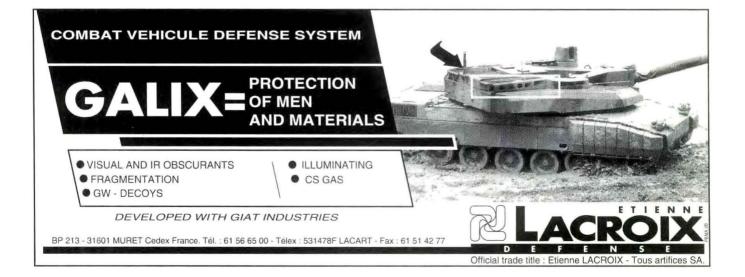
Wegmann 76 mm multi-purpose grenade launcher	Y	ZF LSG 1000 transi
system 190		ZF LSG 2000 trans
Wegmann Type 2706 machine gun mount	Yugoslavia (Serbia/Montenegro)	ZF LSG 3000 trans
Wegmann/Heckler gun mount Type 2365 320	AFV fire control systems	Zaklady Mecaniczn
Wegmann/Heckler machine gun mount Type MZA	ammunition 161	Zeiss AFS-4 AFV gu
1865	driver day and night vision systems 455	Zeiss PERI-R17A1
	laser detectors	automatically stab
	weapons of 20 mm and upward47	Zeiss PERI-R17TW
X		with day and them
		Zeiss PERI-RF gyros
X150-960 diesel engine	Z	Zeiss PERI-ZL gunn
X-200-4 transmission		sighting periscope
X-1100-3B automatic transmission	ZF automatic transmissions, other	Zeiss WBG-X thern
X-200-4 transmission	ZF automatic transmissions, other	sighting periscope

ALPHABETICAL INDEX/W-Z	555
ZF LSG 1000 transmissions	236
ZF LSG 2000 transmissions	236
ZF LSG 3000 transmissions	235
Zaklady Mecaniczne PZL-WOLA diesel engines	240
Zeiss AFS-4 AFV gun-laying and fire-control system	391
Zeiss PERI-R17A1 panoramic periscope with	
automatically stabilised line-of-sight	486
Zeiss PERI-R17TW gyrostabilised panoramic perisc	ope
with day and thermal channels	487
Zeiss PERI-RF gyrostabilised panoramic periscope.	487
Zeiss PERI-ZL gunner's gyrostabilised observation a	ind
sighting periscope with integrated laser rangefind	er 487
Zeiss WBG-X thermal sight for armoured vehicles	

Manufacturers Index

Δ	Atlas Elektronik GmbH		Bulgarian State Factories	
2	DMT 90 dual mode tracker	184	Ammunition	74
	FLP-10/EMES 18 Tank Fire-Control System (TFCS) 3			
AAI Corporation	FLT-2/EMES 15 Tank Fire-Control System (TFCS)			
25 mm Minor Calibre Weapons Station			С	
Ammunition 14 Roller Chain Band track 27		389		
Note: Chair band track	- IFIS	390	CAI see Recon/Optical Inc	
AIL Systems Inc, Advanced Technology Systems	10 18 30 500 10 10 10 10 10 10 10 10 10 10 10 10 1		or it seed the seeding of patients the	
Radar warning receiver			CERACHOC	
HOOM OF THE PERSON AND ADDRESS OF THE PERSON ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON ADDRESS OF THE PERSON ADDRESS OF THE PERSON AND ADDRESS	105 mm TC canister round		Ceramic armour systems	169
ALCOA Composites Inc, FIBERTEK Division	Ammunition	69	CILAS	
Composites M113 modular up-armour kit	Avimo Ltd		APX M504 Gunner's optical sight and rangefinder	
AMCORAM Ltd	Laser Warning Device LWD 21	207	(laser rangefinder)	473
APS-3	2 NV40 gunner's passive night vision periscope	511	APX M550/TCV80 laser rangefinder	
LWS-2 laser warning system			TCV107 laser rangefinder	
WP-7 under armour overhead weapon post	5 NV(L) 3001 day/night laser rangefinder sight family §	512	TCY901 laser rangefinder	
ARMSCOR	Avimo Ltd see United Scientific Holdings plc		TMS301 Eyesafe laser rangefinder	457
76 mm gun (GT 4)			CIS State Factories	
105 mm tank gun (GT 3)			30 mm 2A38M cannon	6
Ammunition			30 mm 2A42 cannon	
Vehicle smoke concealment system	6		30 mm 2A72 automatic cannon	
AV Technology Corporation	BPD Difesa Espazio, Settore Difesa e Spazio		73 mm 2A28 gun 100 mm D-10 series guns	
One Man Armament Turret		106	115 mm U-5TS (2A20) gun	
Two-man 90 mm turret		100	125 mm D-81TM (2A46) smooth-bore gun	
	BRAVIA SA		AT-2 Swatter	
Abu Zaabal Engineering Industries Company	ADV retrofit programs	241	AT-3 Sagger	
115 mm tank gun barrel			AT-4 Spigot	
	Baird Corporation, Optical Systems Division		AT-5 Spandrel	
Aerojet Electronic Systems Division	AN/VVS-2 and NDS-2 passive driver's night vision	440	AT-6 Spiral	
Sense And Destroy Armor Munition (SADARM) 14		448 449	AT-8 SongsterAT-10 Stabber	
Aerojet Ordnance Company	GP/NVG-1 night vision goggles		AT-10 Stabber	
25 mm ammunition (USA)			Explosive reactive armour	
25 mm M919 APFSDS-T ammunition			Passive armour	
30 mm GAU-8/A ammunition 1!		425	120 mm (2A60) breach-loaded mortar	4
30 mm ammunition				
AND A DOCUMENT	Barr & Stroud Ltd		CMI, Cockerill Mechanical Industries SA	
Air-Log Ltd	LF19 laser rangefinder		90 mm gun system	
Running gear systems		515	C25 25 mm turret and CB30 30 mm turret CSE 90 mm turret	
Alcan Plate, Alcan Speciality and Aerospace Ltd	Computerised thermal and optical fire-control equipment	105	CSE 90 mm turret	. 293
Aluminium armour			CSEE Défense	
	IR26 Thermal Imaging Sensor Head (TISH)		EIREL infra-red countermeasures system	. 203
Alenia, Aeritalia & Selenia SpA, Defence Systems Grou	Tank laser sight!		Electric gun and turret drives	
GAQ-4 anti-aircraft system laser rangefinder 4	Thermal observation and gunnery sight!		Man water and a second of	
MTL-8 modular laser rangefinder 4	0		Cadillac Gage Textron	0.5.7
Alenia, Avionic Systems and Equipment Group	Barreiros Hermanos Internacional SA	-popova	20 mm 1 m turret	
V 200 vision block	Ammunition	121	25 mm turret	
C215 gunner's articulated telescopic sight	2		40 mm/12.7 mm Upgunned Weapons Station (UWS)	
P170L and P240L day/night gunner's laser	Bendix Avelex of Canada		76 mm turret	
periscopes		503	90 mm turret	
P186 gunner's telescopic sight	3	303	105 mm low recoil force turret	
P192 night driving periscope 4			LAV-105 mm weapon system	
P204 day/night gunner's periscope 4	MAI resource posterio	220	Machine gun turret	
P223 vehicle commander's night vision periscope 4	15		Twin/combination machine gun (1 m) turret	
P265IL passive night vision elbow	Bharat Electronics Ltd		In-arm suspension systems Turret power control systems	
Alliant Techsystems	Tank fire-control system Mk 1A	391	Weapon/turret stabilisation systems	
24 V electric drive system for lightweight observation	Tank fire-control system Mk 1B	392		
cupolas3	5		Carl Zeiss	
120 mm Smart Target Activated Fire-and-Forget	Blohm + Voss	.71	AFS-4 AFV gun-laying and fire-control system	. 391
(STAFF) 120 mm tank round XM943		171	PERI-R17A1 panoramic periscope with automatically	100
Light turret 24 V electrical drive system			stabilised line-of-sight PERI-R17TW gyrostabilised panoramic periscope with	
Combat Vehicle Armament Technology (COMVAT)		417	day and thermal channels	
somet veneral manient reamloness (conven)	GPA 2000 gun positioning and laying system		PERI-RF gyrostabilised panoramic periscope	
Alliant Techsystems Inc			PERI-ZL gunner's gyrostabilised observation and	
25 mm ammunition (USA)			sighting periscope with integrated laser rangefinder.	
30 mm GAU-8/A ammunition			WBG-X thermal sight for armoured vehicles	. 488
120 mm KE-T round			Administrative account of the second property and account of the second	
Advanced armour systems			Catton and Company Ltd, Defence Products Group	חדמ
Lightweight 30 mm ammunition 1			Tracks	2/0
			Chamberlain Manufacturing Corporation	
AlliedSignal Aerospace Company, Land Vehicle System	s Breda Meccanica Bresciana SpA		Armor Protection Systems (CHAPS)	. 181
Marketing, Bendix Guidance Systems Division	OTO Melara/BREDA T 25 turret		Ammunition	
Gyrocompass Navigation System (GNS) 4				
Multiple rocket launcher system Position Navigation	40 mm 40L70N Fast Forty gun		Chartered Industries of Singapore	
Unit (PNU)		330	Advanced Compact Thermal Imaging System (ACTIS) Ammunition production	
Bendix Artillery Pointing System (APS)			Ammunition production	. 117
Bendix Stabilisation Reference Package/Position	Swingfire	. 60	China National Electronics Import and Export	
Determining System (SRP/PDS)		- 1 T	Corporation	
	British Aerospace Defence Ltd, Royal Ordnance Divisi		Type 82 tank laser rangefinder	
Allison Transmission	30 mm RARDEN ammunition		GM-09 tank fire-control system	. 382
X-200-4 transmission 2			China North Industries Corporation	200
X-1100-3B automatic transmission 2 Transmissions 2			ISFCS-212 Image Stabilised Tank Fire-Control System Type 79-II tank gunner's sight	
1.5	Visual and infra-red smoke screening system		Type 12150L diesel engine	
Alvis Ltd	and the second of the second o		Type 12150L diesel engine, model variants	
30 mm turret	British Steel Stainless Ltd, Armour & Associated		X150-960 diesel engine	
76 mm turret	9 Products	or Constant	Ammunition	
90 mm turret		178	011 - 5	
Daimler Ferret repower package			China Precision Machinery Import and Export	
Scorpion repower package		69	Corporation RAP-130 mm rocket-assisted projectile	0 1
Astronautics C A Ltd	Automatic rammer	00	ner - 130 mm rocker-assisted projectile	8
FCS-10 tank fire-control system3	3 Brunswick Defense		Chinese State Factories	
FCS-10 tank fire-control system 3		200	AT-3 Sagger	53
FCS-30 tank fire-control system			Type 12150L diesel engine	
FCS-40 tank fire-control system	Buck Werke GmbH and Co		Type 12150L diesel engine, model variants	220
FCS-50 tank fire-control system		190	X150-960 diesel engine	221
FCS-61 tank fire-control system			Character to Co.	
FCS-2010 tank fire-control system		244	Chung Shan Institute of Science and Technology M48H advanced fire-control system	405

Companhia Brasileira de Cartuchos (CBC) Ammunition	74	Dunlop Aviation Division, Military Equipment Suspension systems	284	Empresa Nacional de Optica SA (ENOSA) AMX-30E MBT commander's and gunner's optical	500
Computing Devices Canada				equipment AMX-30E MBT driver's periscopes	
Automatic Target Acquisition and Tracking System		E		Improved Mk 7 Laser Tank Fire-Control System (LTFCS)	
(ATATS)	382			for M48A5E MBT	
Commander's display panel				PCN night driving periscope series	
Improved computer control panel		EBO see Hellenic Arms Industry		PP-01 aiming periscope	
M1/M1A1 ballistic computer system		EDO DES FIGURO PARTIS MINISTRY		PP-02 observation and aiming periscope	
M48 ballistic computer system		EL-OP Electro-Optics Industries Ltd		PP-03 aiming periscope	
M60A3 modified fire-control system		BAT-30 computerised fire-control system	397	11 00 anning periodope anning anning anning periodope	000
Mission Management Computer System		Day/Night Range Sight (DNRS)		Ericsson Radar Electronics AB, Surface Sensors Divis	ion
Vehicle Command and Tactical Information System		High Repetition Laser Rangefinder (HRLR) and High		Gunner's integrated tank laser sight	
(VCTIS)	381	Repetition Laser Rangefinder-Eye Safe (HRLR-ES)	459	duffiel a integrated talk laser sight	510
1, 2, 1, 2, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,		Knight family of Advanced Tank Fire-Control Systems	100	Fa-billian and different and de Februarian at Assessment	
Creusot-Loire Industrie		(ATFCS)	395	Etablissement d'Etudes et de Fabrications d'Armeme	ine
Armour plates	170	Lansadot family of armoured vehicle fire-control	000	de Bourges (EFAB)	
ramour potos anamanamanamanamanamanamanamanamanamana	1,0	systems	395	81 mm rapid fire mortar	
Cummings Engine Company Ltd		Matador family of tank fire-control systems		90 mm CN90F3 gun	
AS90 powerpack	243	Mini-laser tank rangefinder		90 mm CS Super (Super 90) gun	
ricoo porto puot riii	. , .	MSZ-2 gunner's day/night periscope		90 mm F1 gun	
Cummins Engine Company Inc		No 5157 second-generation night vision goggles		105 mm 105/57 gun	
Advanced Integrated Propulsion System	256	No 6139 compact driver's night viewer		105 mm CN105F1 gun	
Diesel engines		Passive night vision elbow telescope		105 mm F2 (MECA) gun	
Dieser engines	237			120 mm smooth-bore gun F1	
Czech State Factories		Red Tiger tank fire-control system		120 mm smooth-bore gun G1	7
	204	Tank fire-control systems			
Kladivo tank fire-control system	354	Tank laser rangefinder	459	Etienne Lacroix, Factory and Management	
				GALIX combat vehicle protection system	188
		ERBER			
5		105 mm HE EM 20 carrier round	108	Eurometaal NV	
D				Ammunition	110
		ESD (Pty) Ltd	222	A THIRD TO THE OWNER OF THE OWNER OF THE OWNER O	110
		Generic brushless low voltage gun control equipment .	367	Euromissile, Dynamics Group	
DEFTEC SA		High Integration Technology Tank Fire-Control System		HOT	EE.
105 mm HEAT-T round	124	(HITT-FCS)		MILAN	
		M41 gun control system		TRIGAT Programme	
Daewoo Corporation		Main Battle Tank (MBT) gun control system	368	TRIGAT Frogramme	37
Ammunition	110			F	
		EXPAL – International Division		Euromissile GIE	000
David Brown Vehicle Transmissions Ltd		Ammunition	122	HOT Mephisto system	
HMPT-500 transmission	268			HOT UTM 800 turret	
P40 transmission	252	Elbit Ltd, Advanced Technology Centre		MILAN Compact Turret (MCT)	323
TN37 transmission	252	1 inch bi-ocular armoured vehicle display	489		
TN54 transmission	251	All-electric turret/gun drive and stabilisation system		Europa Metalli – LMI SpA	
New transmissions		CELTICS Commander's Extended Link Thermal Imaging		Ammunition	108
		Combat Sight			
Delco see General Motors Corporation		Electrically stabilised weapon and turret drive system		Explosivos Da Trafaria SA	
		Knight family of Advanced Tank Fire-Control Systems	000	Ammunition	115
Delco Systems Operations		(ATFCS)	395	raminament i i i i i i i i i i i i i i i i i i i	
LAV-25 25 mm turret	354	Lansadot family of armoured vehicle fire-control	000		
DIT EV COTTILL BITCH SIMILARING		systems	395		
Denel (Pty) Ltd, LIW Division		Matador family of tank fire-control systems		F	
Armscor 20 mm G12 automatic cannon	26	Tank fire-control systems			
Armscor 20 mm GA1 automatic cannon		Tank inc control systems	004		
Armscor 35 mm GA 35 automatic cannon		Electronics & Space Corporation		FMS Corporation	
Armsedi 33 min da 33 automatic camion	. 25	Ground-Launched Hellfire-Heavy (GLH-H) turret	261	AFV upgrades	265
Detroit Diesel Corporation				Arv upgrades	205
	260	TOW Under Armour (TUA) turret		FMC C	
Engines	200	TOW Under Armour (TUA) turret, model variants	. 500	FMC Corporation, Ground Systems Division 12.7 mm machine gun turret	250
Deutsche Aerospace AG, Defence Systems Group		Electronintorg Ltd			
			EAF	25 mm Autocannon turret	
Common Opto-electronic Laser Detection System	204	Shtora 1 AFV defence system	545	25 mm electric drive turret	
(COLDS)	204	FI : 15 11 1		25 mm Enclosed Weapon Station	
81116		Eloptro (Pty) Ltd		25 mm two-man turret	, 355
Diehl Group, Ordnance Division		Eland night sight adaptor Type NA-10	. 505	40 mm/12.7 mm Enclosed Weapon Station	351
120 mm mortar system	16	Integrated day/night gunner's sighting system GS-21S			
D. 11D				FMC Corporation, Naval Systems Division	-
Diehl Remscheid GmbH & Co		Laser elbow Type LE-20		Cannon-Calibre Electromagnetic Launcher (CCEML)	42
Armour systems		LR 20 laser rangefinder		Electromagnetic Focused Technology Demonstrator	6134
Track system	270	LT-20 laser rangefinder		(EMFTD)	
		ND-15 night driverscope		Electrothermal-Chemical (ETC) gun propulsion system	
Diehl-Wehrtechnik		ND-20 night driver's periscope		Pulsed power development	39
76 mm vehicle fragmentation grenade		Night elbow Type NE-20		9-MJ Electrothermal skid gun module	
Ammunition programme	94	Night vision adaptor NA-20		Laboratory Electrothermal-Chemical gun development	
		Thermal elbow TS-30	507	ETC and gun propulsion process development	39
Direccion General de Fabricaciones Militares (DGFM)		TV camera adaptor TE-20	505		
20 mm VCTP turret				FMC Corporation, Steel Products Division	
76 mm grenade launching system		Eltro GmbH, Gesellschaft für Strahlungstechnik		Track shoes	276
105 mm FRT L44 D1504 Type CN105F1 gun	1	CE624 laser rangefinder	. 458		
105 mm FRT L51 tank gun		CE628 laser rangefinder		FN Herstal	
105 mm TAM tank turret	291	CE632 laser rangefinder		7.62 mm GPMG	49
Ammunition		CE619 laser rangefinder		12.7 mm M2 HB (QCB) machine gun	
A CONTRACTOR OF THE PROPERTY O					73



FOREX SA Ammunition	124	30 mm Model 781 automatic gun		Powerpacks	
	12.	80 mm smoke canisters	189		LOO
Fairey Hydraulics Ltd Autoloaders	67	81 mm gun-mortar turret (TMC 81)		Hsing Hua Company Ltd Ammunition	. 133
Falat Cabasida F. A /C		105 mm 105 G1 gun		Husban Aircraft Company Floatra Ontical Systems	
Falck Schmidt, E. A/S M41 diesel repower package	221	105 mm 105 G2 gun		Hughes Aircraft Company, Electro-Optical Systems AN/VAS-3 driver's thermal viewer	450
		105 TML turret	297	Armoured Gun System (AGS) gunner's primary sight	528
Federal Directorate of Supply and Procurement (SDP Laser irradiation detector		APX M504 Gunner's optical sight and rangefinder (line of-sight deflector)		Day/night gunner's Integrated Sight Unit (ISU) Day/Night Range Sight (DNRS)	
Ammunition		GALIX combat vehicle protection system	188	Electro-Optical Tracking System (EOTS)	. 529
Enineschopische Marko Maion (EMM) Could		Ammunition		GMHE Integrated TOW Sight (GITS)	
Feinmechanische Werke Mainz (FWM) GmbH Gun control and stabilisation systems	365	Armour systems		Gyrostabilised Gunner's Primary Sight (GPS) High Repetition Rate Eyesafe laser rangefinder	
		Mascot remote-controlled 7.62 mm machine gun		Infra-Red Equipment (HIRE) for gunner's periscope	
Ferranti International Vehicle support systems	547	mount		sights Low Repetition Rate Eyesafe laser rangefinder	
	017	Toucan II turret	305	M1 Abrams Thermal Imaging System (TIS)	529
Flensburger Fahrzeugbau-Gesellschaft mbH M41 repower package	227	TS 90 90 mm turret		M1 MBT laser rangefinder M1A2 Gunner's Primary Sight Line-of-Sight Subsystem	
M113 APC modernisation		13 30 30 mm turiet, model variants	201	(GPS-LOS)	
F		Giat Industries/Mécanique Creusot-Loire	170	Second Generation Tank Sight (SGTS)	. 529
Francis B WIlmott Suspension components	285	Add-on armour kitsCB 60 HB shield gun racer for 60 mm mortar			
		CB 127 VE shield gun racer for 12.7 mm machine gun		Hughes Aircraft Company Missile Systems	co
Fraser-Volpe Corporation M19A1 driver's night periscope	450	CB shield gun racer for 7.62 mm machine gun		BGM-71 TOW	, 62
The state of the s		CP 127 A pivot gun racer	. 313	an and	
G		Leclerc automatic loader for Leclerc MBT P 127 A pivot mount		ľ	
		STB V shield rotary mount			
CE Assessed Assessed Systems Bonortment		STBE shield rotary mount		IMO Industries Inc, Miller-Holwarth Division	E25
GE Aerospace, Armament Systems Department Blazer air defence turrets	352	STR rail-mounted rotary mount STRTA all-round rail-mounted rotary mount		Armoured vehicle periscopes	035
Blazer air defence turrets, model variant		T.20 turret	304	INDEP - Industrias e Participaões de Defesa, SA	
GE Aerospace, Defense Systems Department		T.25 turret TLi 52 A machine gun turret		Ammunition	115
All-electric stabilised weapon control systems		TLi 127 close defence cupola	306	ITT Defense, Electro-Optical Products Division	
Armored Gun System (AGS) all-electric stabilised turret		TLiG series of machine gun turrets		Improved AN/PVS-7B Gen III passive night vision goggles	450
drive system	3/5	TOI observation and intervention cupola	. 307	goggies	450
GEC Avionics Ltd, Guidance Systems Division		Greek Powder & Cartridge Company (PYRKAL)		IVECO FIAT SpA, Defence Vehicles Division	000
Azimuth Position and Elevation System (APES) Land Navigation System (LNS)		AmmunitionGRL-76-10 76 mm tank close defence system		Family of diesel engines	239
				Inframetrics Inc	
GEC Sensors Ltd, Electro-Optical Military Division Multisensor platform	516			Infra-Red Imaging System (IRIS)	548
S100/SS110 night sights		н		Intertechnik GmbH	
SS120 commander's night sight				155 mm M109 rammer EFS explosion suppression system	65
SS122 series armoured vehicle day/night sights		Oy Hackman AB		MFS engine compartment fire extinguishing system	
SS141, SS142 commander's night and SS162		Cartridge cases	87		
commander's day vision periscopes		Hägglunds Vehicle AB		Iraqi Government facilities AFV armour packages	172
SS500 series armoured vehicle thermal sights	519	20 mm gun turret Rh 202			0.000
Tank Thermal Sensor (TTS)	516	20 mm turret HS 804		Iskra Elektrooptika Ljublijana D. D. EFSC-3 tank fire-control system	401
GEC-Ferranti Defence Systems Ltd, Display Systems		Two-man 25 mm gun turret		Laser irradiation detector and warner	
Division	200	Two-man 30 mm gun turret	. 335	LD-TŠ laser rangefinder for T-55 MBT gunner's sight . SG-55A tank commander's gyrostabilised sight	
Type 453 laser warning receiver Type 520 laser rangefinder		Haley & Weller Ltd		TLMD-3 tank commander's gyrostabilised signt	
Type 629 lightweight modular laser rangefinder		Vehicle grenades	. 197		
GEC-Ferranti Defence Systems Ltd, Navigation and		Heckler & Koch GmbH		Israel Aircraft Industries Ltd, Electronics Division Directional Gyro Indicator (DGI)	424
Electro-optics Systems Division		Gun mount Type 2365		Guns Orientation and Navigation System (GONS)	423
FIN 1155 land navigation and attitude reference system	425	Machine gun mount Type MZA 1865	321	Land Navigation System - Mark I (LANS Mk I) Land Navigation System - Mark II (LANS Mk II)	
FIN 5500 land navigation and attitude reference		Helio Mirror Company Ltd		Land Navigation System - Mark IV (LANS Mk IV)	422
Positioning and Azimuth Determining System (PADS)	. 426	AFV periscopes Buffered mounts for 7.62 mm and 12.7 mm machine	520	North Finding Module (NFM) Vehicle Navigation System (VNAS)	
Mk 2	. 426	guns			
GEC-Marconi Dynamics Ltd		Chieftain No 17 Mark 2 AFV cupola		Israel Aircraft Industries Ltd, MBT Systems and Spa Technology	ice
Tank Anti-Missile System (TAMS)	. 208	FVH 300 high angle 7.62 mm or 12.7 mm machine	343	Howitzer Advanced Fire-Control System (HAFCS)	398
		gun hatch	345	Israel Aircraft Industries Nimrod	58
GIWS see Gesellschaft Für Intelligente Wirksysteme mbH	3	HMD 848 lightweight, fighting vehicle, commander's cupola	344	MBT G360 20 mm multi-purpose light cannon	22
		Mirror Company LWD 21 Laser Warning System	208	Israel Military Industries Ltd see TAAS - Israel Indus	stries
GKL Equipment PTE Ltd FV600 upgrades	245	Multipurpose grenade discharger systems No 16 and No 26 lightweight cupolas		Ltd	
	10	No 27 lightweight AFV cupola			
GKN Defence	242	Holianelia Company for Chaminal Industries		К	
Light turret	. 540	Heliopolis Company for Chemical Industries Ammunition	84		
General Dynamics, Land Systems Division	4.0			KONI BV	001
ETC	40	Hellenic Arms Industry (EBO) Ammunition	101	Hydraulic shock absorbers	28
General Electric Company				KUKA Wehrtechnik GmbH	
Advanced Integrated Propulsion System	256	Hercules Aerospace 155 mm Unicharge	. 144	Gun mount E6-II-25 Gun mount E6-IIA1	
General Electric Company, Defense Systems Depart	tment	Control of the Control of Control	1 17	Load assist device for 155 mm artillery systems	66
Block III demonstration Electric Gun and Turret Drive (EGTD)	265	Hercules Defense Electronics Systems Inc 120 mm X-ROD autonomous tank round	160	One-man turret E23 Two-man low-profile turret E4A1	
HMPT-500 transmission		120 mm X-100 autonomous tank round	100	Two-man Marder 1 turret	315
HMPT-1000 transmission	269	Hispano-Suiza	200	Type 605 12.7 mm turret	
Liquid propellant guns	36	H 60 series of turrets Lynx 90 turret		KVH Industries Inc	
General Motors Corporation, Delco Systems Operat		Lynx 90 turret, model variants	299	MV103 series digital fluxgate compasses	428
Thermal sight for the LAV-25	526	Mangouste 60 mm/12.7 mm turret Puma cupola		Kader Factory for Developed Industries	
George Blair plc, Defence Products Division		Serval 60/20 turret		76 mm smoke grenade launcher system	
Tracks	273	Honeywell Military Avionics Division		M113A2 add-on armour kit	167
Gesellschaft Für Intelligente Wirksysteme mbH (GIV	NS)	Modular Azimuth Position System (MAPS)	431	Kaha Company for Chemical Industries	
SMArt 155 mm projectile				Screen smoke grenades	
Giat Industries		Honeywell Regelsysteme GmbH, Aerospace and De 24 V electric drive system for lightweight observation		Type 270/M239 66 mm smoke grenade launcher	18
12.7 mm CIBI 50 turret		cupolas	375	Kearfott Guidance and Navigation Corporation	
20 mm CAPRE turret		Light turret 24 V electrical drive systemMBT turret 24 V electrical drive system		Land Navigation System (LNS) for combat/surveilland vehicles	
20 mm M621 (F1) cannon			3/5	Miniature Integrated Land Navigation System	
25 mm DRAGAR turret	302	Horstman Defence Systems Ltd Gun control equipment	270	(MILNAV)	
25 mm Model 811 automatic gun	13	dan control equipment	3/0	Modulal Azimuti Fusition System (MAFS)	43

Modular Azimuth Positioning System with Global Positioning System (MAPS/GPS)	Makina ve Kimya Endüstrisi Kurumu Ammunition	133	o	
Kentron		. 100	OTO Melara	
ZT-3 Swift	Marconi Defence Systems Ltd Series 1220 laser warning receiver	. 209	60 high-velocity gun system	
Kidde-Graviner Ltd	Managina de la Castral Castral Castral de la Castral C		76 mm OTO Melara ammunition 105 low recoil force gun	
Crew Bay explosion, detection and suppression	Marconi Radar and Control Systems Ltd Centaur tank weapon control system	. 405	120 smooth-bore gun	. 22
system 214 Engine Bay fire detection and suppression system 215	Digital Fire-Control System		SIDAM 25 anti-aircraft turret	
Integrated Control Unit	GCE 628 gun control and stabilisation equipment Gunner's Thermal Imaging Vehicle Sight (TIVS)		T 90 CKL turret	
V-II	Marksman twin 35 mm anti-aircraft turret	. 341	TC 20 turret	
Kollmorgen Corporation, Electro-Optical Division Model 220 fire-control sight	MOGUL Modular Gun Laying system	. 371	TPT Mk 4 12.7 mm turret	
Model 317 night vision kit for M20 sight 532	PD700 light armoured vehicle dual axis power drive system	372	T 25 turret	
Model 910 integrated sight			Oerlikon-Contraves AG	
Model 939 gunner's auxilliary sight	Marotta Scientific Controls Inc Automatic explosion suppression system	217	20 mm Type KAA cannon	. 3
Model 957 squad leader's search periscope	Automatic explosion suppression system	, 217	25 mm automatic cannon Type KBA	
Model 998 fire-control backup sight 535	Martin Marietta Aerospace and Naval Systems		25 mm Type KBB cannon	
Kollsman see Sequa Corporation	Composite armour	. 184	35 mm cannon Type KD series	
Korea Explosives Company Ltd	Martin Marietta Corporation, Milan Army Ammunition	on	Oerlikon-Contraves AG, Pyrotec	
Ammunition	Plant Ammunition	145	Ammunition	13
Krauss-Maffei Wehrtechnik GmbH	Ammunition	145	Officine Galileo SpA	
Hydraulic bump stops	Martin Marietta Orlando Aerospace		ATREOST tank fire-control system	39
Vicena Francis A/C Defense Bradusta Castina	Copperhead 155 mm Cannon-Launched Guided Projectile (CLGP)	144	JANUS fire-control system	
Kvaerner-Eureka A/S, Defence Products Section Armoured launching turret for TOW missile systems 331	Hellfire modular missile system		OG 14 L2B tank laser fire-control system	
			Madis sighting and drive system	49
L	Mauser-Werke Oberndorf GmbH MK 25 mm x 137 Model E cannon	10	OG-P20 periscope sight	49
L	MK 30 mm x 173 Model F (MK30) cannon		OG-P07 periscope sight	
			Thetis thermal tank infra-red system	
LIW see Denel (Pty) Ltd	Mécanique Creusot-Loire see Giat Industries		Vehicle commander's SP-T-694 gyrostabilised panoramic day/night sight	49
Leica AG	Meccania per l'Elettronica e Servomaccanismi SpA		VIR52 gunner's night vision periscope	
BIG2 commander's night vision goggles 510	(MES) VG/DIL 186 day and night driver scope system	112	Oldelft	
Leica AG, Special Products Division		. 442	Lightweight Universal Night Observation System	
SRZ/SKS muzzle boresight 510	Menachem Urman and Company Ltd	004	(LUNOS)	
Linamar Machine Ltd	Centurion tank commander's cupola	324	Low Light Level Television System Type GS6TV	50
TOW-Armoured Launching Turret (ALT)	Messier Auto Industrie		fighting vehicles	50
Litton Laser Systems	Suspension systems	278	Mk 3 thermal observation and aiming system for MBTs	EΛ
TK-640 laser rangefinder	Miller-Holzwarth see IMO Industries Inc		RSI tank laser rangefinder	
Line Community Day of Division	Marine A. P. Communication		TILAS tank laser sight	49
Litton Systems Inc, Electron Devices Division M-912A/M-915A night vision goggles	Ministry of Defence, India Ammunition	102	Type LAT laser rangefinder for tanks	
M-972/M-973 night vision goggles451			Type PG1MS night vision goggles	44
Loral Control Systems	Mitsubishi Electric Company Type 90 MBT Fire-Control System (FCS)	401	Type TS7TS gunner's passive aiming sight	50
155 mm expendable jammer XM867 AD/EXJAM 151	Type 30 MbT Fire-control System (FCS)	401	Oldelft Group, OIP-Instrubel NV/SA	
Laval Flactic Optical Systems	Moked Engineering (1969) Ltd	205	HNV-1 holographic goggles	43
Loral Electro-Optical Systems Hardhat ATGW decoy system	Third Eye laser warning system	205	Olin Ordnance	
	Mondial Defence Systems Ltd		20 mm ammunition	
Loral Infra-red and Imaging Systems Gunner's day/night thermal Tank Periscope Sight	Track system	276	Ordnance ammunition	14
(TPS)	Moteurs Baudouin		Optic Electronic Corporation	
Thermal Sight (ITS)	6-cylinder diesel engines	222	AN/VVG-2 commander's integrated laser rangefinder	
Loral Vought Systems	Moto Pecas		Driver's night viewers family EGLE laser rangefinder kit	
Hypervelocity (HVM) Programme	Gunner's shield for M113 commander's cupola		GNP 55 gunner's night vision periscope	
Lotus Engineering	M113 diesel conversion	220	Gunner's sight integrated ranging equipment M36- SIRE	54
Active suspension system 548			M26 muzzle boresight	54
Lucky-Goldstar International Corporation	N		M32E1 tank gunner's periscope	
Track shoes			M36E1 day/night tank periscope	53
	NANOQUEST Defence Products Ltd		M105 series gunner's articulated sighting telescopes	
М	L20 series sight laser rangefinders	522	MP86 multi-purpose gunner's periscope	
	L50 series sight laser rangefinders	522	NV38 driver's viewer	45
ML Aviation Ltd	NAPCO International Inc		NV43FL driver's night and emergency day/NBC viewer	4
'T' tank gunner's telescopic laser rangefinder sight 467	Retrofit power packages	. 261	NV46S commander's passive night vision periscope	53
MMC Engineering Services Sdn Bhd	NFT, Manufacturing Division		NV52 day/night vision periscope	53
V-150 Commando repower kit	Electric drive systems for gun turrets	367		
MRT Weepon Systems and Israel Aircreft Industries	NICO Pyrotechnik		Optronic Instruments & Products (OIP) Oldelft LRS 5 fire-control system	-0-
MBT Weapon Systems see Israel Aircraft Industries	NICO Pyrotechnik Vehicle grenades	192	Oldelft LRS 5 fire-control system. Oldelft LRS 5 fire-control system, model variants	
MECAR SA			Oldelft LRS 7 fire-control system	
90/28 mm light gun system2 Improvement Programme for 90 mm Cockerill Mk III	NIMDA Company Ltd Retrofit powerpacks	237		
90 mm ENGESA EC-902	application to the property of	201	P	
Ammunition70	NORINCO, China North Industries Corporation	EO		
MTU Motoren-und Turbinen-Union Friedrichshafen	Red Arrow 8 Type 1985 passive night vision goggles		PB Clermont	
GmbH	Type TDPN-2 driver's night viewer		SNPE combustible cartridge cases	8
Powerpacks 231 Power systems 228	NWM De Kruithoorn BV		PEO Warszawa, Industrial Centre for Optics	
	Ammunition	112	Driver's night vision goggles	
Maasara Company for Engineering	Night Vision Equipment Co Inc		Driver's passive night vision periscope	44
Ammunition	NIGht Vision Equipment Co Inc NVEC 800/NVEC 800 HP night vision goggles	451	Tank fire-control systems	40
McDonnell Douglas Helicopter Company	27/10/10/2000 STRENGES - SENSESSEE - PROSESSEE - PROSESSEE - BERNAMON - CO.		PHOTONIC Optische Geräte GmbH	-
25 mm M242 Bushmaster cannon	NobelTech Electronics AB Integrated tank fire-control system Type FV	403	FSC-530 fire-control system for recoiless guns	37
30 mm Bushmaster II automatic cannon	Type FV day/night gunner's sight	509	PYRKAL see Greek Powder & Cartridge Company	
30 mm M230 Chain Gun automatic cannon	Universal Tank and Anti-Aircraft Systems – UTAAS	404	Pacific Scientific, HTL/Kin-Tech Division	
40 mm Bushmaster IV automatic cannon	Norsk Forvarsteknologi AS (NFT)		Automatic Fire Extinguishing Systems (AFES)	2
	25 mm MK 25 Model E vehicle-mounted turret	331		
Magellan Systems Corporation NAV 1000 M5 Global Positioning System (GPS)	North American Dynamics		Pakistan Ministry of Defence, Institute of Optronics AN/PVS-5A night vision goggles	4
	M113 universal gun mount	353		
Magnavox Electronic Systems Co, West Coast Division GPS Engine™ turbo version	North Korean State Factories		Pakistan Ordnance Factories (POF) Ammunition	1
MX7120 with remote control display unit	AT-3 Sagger	53		

66 mm grenade dischargers	198	Stratified Charge Omnivorous Rotary Engine (SCORE) .	258	OB-60 day/night driver's periscope	439
				CN2-500 passive driving periscope series	437
Perkins Engines (Shrewsbury) Ltd	0.07	Royal Ordnance	0.5	ESTER 10 laser rangefinder for AFVs	
X-200-4 transmission 100 series diesel engines		30 mm RARDEN L21 gun		HL 33 daylight panoramic observation telescope M371 episcopic sight	
Condor diesel engines		105 mm Improved Weapon System		OB-47 tank gunner's night sight	
Eagle Tx diesel engine		105 mm L7 tank gun series	33	SOPTAA 19 fire-control system	. 387
Phaser diesel engines		105 mm low recoil force gun		SOPTAC 11 fire-control system	
Powerpacks		105 mm T-54, T-55 and Type 59 gun conversions		SOPTAC 26 fire-control system	
T6.3544 diesel engine	240	115 mm tank gun barrel 120 mm armoured mortar system		SOPTAC 36 fire-control system	
Philips GmbH, Unternehmensbereich Systeme und		120 mm L11 tank gun		TELAB laser rangefinder	
Sondetechnik		120 mm L11 tank gun, model variants		TJN2-71 day/night optical sight	
BM8025 night aiming and observation system	484	120 mm L30 tank gun	31	TN2-1 night vision binoculars	438
		Electro Thermal Chemical guns		CF 570 CCD video camera for armoured vehicles	
Pilkington PE Ltd	Enn	ROMOR appliqué armour systems	179	SOPTAC 11 IR control system	
Condor commander's day/night sighting system Nova general-purpose night vision goggles		Royal Ordnance see British Aerospace Defence Ltd		TELAB laser rangefinder	
Osprey combined day/night laser sight		noval ordinance see british Aerospace Defence Eta		With ital ine-control system	. 500
Passive night vision driving periscope	448	Rudi Căjavec, Defence Electronics		SSAB Oxelösund	
Raven combined day/night sight		SUV-T55A tank fire-control system		ARMOX armour	. 176
Sabre day and day/night vehicle sights	. 524	SUV-T55A tank fire-control system, model variants	411	Saco Defense Inc	
Polish State Factories		SUV-T55A tank fire-control system	410	7.62 mm M60E2 machine gun	40
Explosive reactive armour	. 175	es ches clarity as a construction of the const		Defense 40 mm Mk 19 Mod 3 machine gun system	
		Ruggieri			
Poongsan Metal Corporation	100	Spider close-in vehicle defence system	189	Santa Barbara Research Center	0.47
Ammunition	109			Explosion/fire protection system Laser warning sensor	
Protective Materials Company		S		Laser warriing sensor	. 21
M113 spall suppressant armour system	. 184			Sekur SpA	
				Track links	. 273
		SACM Diesel			
		Diesel UDX range of military engines	224	Self-Changing Gears Ltd	25
R		SAGEM, Département Navigation, Aéronautique et		T320 transmission TN12 transmission	
		Terrestre		TN15 transmission	
RAFAEL		CITA 20 navigator and inertial goniometer	414	TN26 transmission	
NITE LITE target acquisition system		NSM 20 land navigation system	414	M113 technology demonstrator	
Overhead Weapon Station		SIGMA 30 ring laser gyro inertial navigation system			
Rafael periscopic viewing sight		ULISS 30 Position and Azimuth Determination System		Sequa Corporation, Kollsman Division	FO
Rafael RAFCOM-1 heading reference system Upgrading of combat vehicles		(PADS)	415	Day/Night Range Sight (DNRS)	53
opgrading of compact vertices	200	SAKO Ltd		Servo Hydraulics Lod (SHL)	
RAFAEL Armament Development Authority		Ammunition	87	Turret system upgrade packages	. 36
Screen obscurant smoke system	193				
DANITA Churching and Contain Ltd		SANTA BARBARA SA 40 mm SB40 LAG automatic grenade launcher	26	Sextant Avionique, Navigation Systems Division	
RAMTA Structures and Systems Ltd Improved TOW/MAPATS vehicle	326	Ammunition		ARVERNE (APX M539) magnetic heading indicator system	41
Imployed 1917/ Will 7119 Vollade Institution	020	Explosive ractive armour		NAVYX position determining system	
RAPHAEL Armament Development Authority		SABBLIC passive armour		SYDADE land navigation system	. 41
Toga add-on passive armour		TC-3 (A-1) 12.7 mm turret		TMV 565 monochrome TV micromonitor	47
Blazer explosive reactive armour	1/3	TC-3 (A-1) 12.7 mm turret, model variants TC-9/OP and TC-17/CL turrets		Siemens AG	
RAUFOSS A/S, Defence Products Division		TC-9/OP and TC-17/CL turrets, model variants		Type LEM 3 laser rangefinder	45
Ammunition	113	TC-13/M242 turret		Type LEM 5 labor langumest amananananananan	1
Instantaneous smoke screening systems		TC-25/M242 turret		Simmel Difesa SpA	
				Artillery ammunition	10
RDM BV General Engineering Department AFV retrofit packages	240	SDPR – Federal Directorate of Supply and Procurem 0 mm M89 cannon		Singapore Automotive Engineering Pte Ltd	
Arv retroit packages	240	30 mm M86 cannon		Services	24
REMIE SpA		PN-2 passive night vision goggles			
Ammunition	108	PPV-2 passive night vision periscope		Slovakian State Factories Kladivo tank fire-control system	20
		SUV-84 tank fire-control system		Kladivo tank fire-control system	30
Racal Radar Defence Systems Ltd	210	Anti-tank gun fire-control system	. 410	Smiths Industries	
Saviour laser warning system	210	SESM (Société d'Equipements Systèmes et		Model 9265 Vehicle Navigation Aid System (VNAS)	
Recon/Optical Inc, CAI Division		Mécanismes)		POS-NAV Position Navigation System	43
Armoured vehicle optical systems	525	Transmissions ,	. 226	Sociedad Anonima de Placencia de las Armas	
Barrier Haller and Branch		CEMAL		Ammunition	
Renault Véhicules Industriels, Defence Direction Engines	224	SFIM Industries HL-70 commander's gyrostabilised panoramic sight	177	CD-850 transmission production	
Transfluide transmission		SILVER strapdown Attitude and Heading Reference	- 107 1	X-200-4 transmission	26
		System (AHRS)	416	Sociedade Portuguesa de Explosivos (SPEL)	
Renk AG		SILVERNAV land navigation system		Ammunition	11
Other tank transmissions		Sirius daytime thermal panoramic stabilised sight		6 **** NA 15 ** 1 NA 15 *** 1000	
HSWL 106 transmission		VISAA stabilised anti-aircraft sight		Société d'Applications des Machines Motrices (SAN BTM family of light turrets	
HSWL 284 transmission		VS family of gyrostabilised sights		CE 10 electric turret drive system	
HSWL 354 transmission	233			CE 15 electric turret drive system	36
RK 304 transmission		SHL (Servo Hydraulics Lod)		CE 24 electric turret drive system	
Transmissions for heavy wheeled vehicles	. 234	Hydraulic bumpers	. 281	CE 40 electric turret drive system Electric stabilised drive controls	
Rheinmetall GmbH		SIG-Swiss Industrial Company, Power Transmission		PCE 21 G 15 gunner's weapon control station	
120 mm smooth-bore gun	15	Control Division		Suspension systems	
120 mm smooth-bore gun model variant	15	All-electric turret drive and gun laying system with digi		TAB 220 20 mm anti-aicraft turret	30
20 mm automatic cannon MK 20 Rh 202		AC servos (dACs) and brushless technology	. 370	TTB 190 90 mm turret	29
20 mm TS-15 turret family		Brushless 24 V DC electrical gun control and	260	Société d'Applications Cénérales d'Electricité	
20 mm turret TF 20 15		stabilisation system		Société d'Applications Générales d'Electricité et de Mécanique (SAGEM), Département Viseurs	
105 mm tank gun family		T-54/55 gun control retrofit kit		DANAOS Day And Night Artillery Observer System	47
120 mm under armour mortar system	17	Universal control handles		M389 commander's panoramic sight	
140 mm smooth-bore gun		CIONIANI NEC		Stabilised Aiming, Vertical Sensing and Navigation	
Ammunition		SIGNAAL Usfa UA9630 driver's universal passive periscope series	442	(SAVAN) gunner's multi-channel stabilised sight VIGY 40 commander's modular stabilised panoramic	
TS-7 20 mm turret		UA 9124/9126 day/night periscope sight system		sight	
Twin 7.62 mm machine gun turret TUR-1		UP1011 and UP1001 day/night aiming and		- W 15	
of Swaper automorphisms and approximation with the state of the state of the second of the second of the state of the state of the second of the state of the sta		observation systems	. 502	Société d'Optique, Précision, Electronique et Mécar	nique
Rockwell International, Collins Avionics &		CIMPAD O 1 - 1 - 10		(SOPELEM)	
Communications Division Mission Planning Station for Tropper™ handheld /		SIMRAD Optronics A/S	111	APX M504 Gunner's optical sight and rangefinder	17
Mission Planning Station for Trooper [™] handheld/ vehicular GPS receiver	420	GN1 night vision gogglesLA7 laser rangefinder		(optical sight)	- 4/
Trooper™ handheld/vehicular GPS receiver		LV5 laser rangefinder		Société Anonyme Belge des Constructions	
Miles and the second process of the second proces of the second process of the second process of the second pr		LV350 series laser rangefinders	463	Aéronautiques (SABCA)	
Rockwell International Corporation, Tactical System	ns	LV400 series laser rangefinders	463	Titan family tank fire-control systems	37
Division	100	RL 1 laser warning receiver	205	ATLAS family advanced tank laser fire-control	-
Multi-sensor Target Acquisition System SLID Small, Low-cost Interceptor Device		SNC Industrial Technologies Inc		systems Universal tank fire-control system	37
Hellfire modular missile system		Ammunition	76	Chiversal tank in Country system	0/
				Société Anonyme Belge des Constructions	
Romanian State Factories		SNPE - Société Nationale des Poudres et Explosifs		Aéronautiques (SABCA), Electronics Department	
Ammunition		Combustible cartridge cases		Thermal Imaging Sight (TIS) system for Leopard 1 MBT	1-
vvairing system on caser munimation (vvsci)	200	modification in architecture reactive armour	105	mil 1 months of the management of the community of the co	+1

U

Société Anonyme de Télécommunications (SAT)

Société de Constructions Panhard et Levassor

Société Des Céramiques Techniques (SCT)

AFV driver's night vision equipment T-54, T-55 and T-62 MBT fire-control systems ...

T-64, T-72 and T-80 MBT fire-control systems

TNA-4 Tank Navigation Apparatus

Suppression System (AFEDSS)

Steelcore Heavy Equipment Armour systems

SP1/127 weapon station SP2/300 weapon station

SP3/300 weapon station

Swiss Federal Armament Works

TAAS - Israel Industries Ltd

combat vehicles

Ammunition ...

AT-3 Sagger

Teldix GmbH

Diesel engines

Drozd (Thrush) dynamic defence system Passive AFV protection system

Automatic Fire and Explosion Detection and

Stevr-Daimler-Puch Spezialfahrzeug AG

120 mm compact tank gun (smooth-bore) 140 mm tank gun

Swiss Industrial Company (SIG), Power and Transmission Control Division

120 mm smooth-bore tank gun

Pedestal Operated Multi-Ammunition Launching

FNA 50 vehicle navigation system
FNA 55 vehicle navigation system
NKA 55 North-seeking syro system
Vehicle navigation systems
FOA 25 FOA 50 vehicle orientation systems

Teledyne Continental Motors, General Products

Telefunken Systemtechnik GmbH, Aerospace AG -LLLTV aiming and observation system with IR scanner

105 mm Low-Profile Turret (LPT)

External suspension systems

Type PZB 200/IRS 100

Taiwanese State Factories

Talley Defense Systems Inc

Extended range ammunition .

T

60 mm Hyper-Velocity Medium Support weapon (HVMS

481

223

169

105

437

384

383

412

186

186

545

213

546

293

292

28

66

21

194

103

195

173

53

150

346

263

Group

Avenger laser rangefinder

TTS laser rangefinder .

Textron Lycoming AGT 1500 gas turbine

Thiokol Corporation

Thomson Brandt Armements

60 mm MCB 60 C gun mortar 60 mm MCB 60 LR gun mortar

Countermeasures Division

MIRIADE radar warning receiver

CT-30 thermal fire-control system

OB-41 night driving binoculars OB-60 day/night driver's periscope

M113 supplementary armour kit

POLUX light optronic processor SOPTAC 11 IR control system UGO observation and driving goggles

Tracor Aerospace, Expendables Division

DIVT 13 night gunsight system Mithridat fire-control system

OB-31 night driving periscope

Thyssen Henschel

81 mm MCB gun mortar

Camille fire-control radar

Ammunition

Ammunition

ISU day/night gunner's Integrated Sight Unit

Texas Instruments Inc, Electronic Systems Division AN/VSG-2 Tank Thermal Sight (TTS)

Combat Vehicle Thermal Targeting System (CVTTS)

Extended Range Gunnery Fire-Control Demonstration

Gunner's Primary Tank Thermal Sight (GPTTS) ... Improved M60A3 fire-control system

sight system Lightweight Modular Thermal Sight (LWMS)

Modular Target Acquisition System (MTAS) Tank commander's independent thermal viewer Thermal Imaging Multisensor System

Thomson-CSF Aerospace Group, Radars and

Thomson-TRT Défense, Optronics Division

Athos thermal imaging system

120 mm under armour mortar

Soviet State Factories, former

CIS smoke systems ...

Spectronix Ltd

Flick rammer

Ceramic armour

Soltam Ltd

Ammunition

US Army Laboratory Command, Materials Technology Laboratory	
Composite developments (USA)	
US Army Tank Automotive Command	
Combat Vehicle Command and Control (CVC ²) 392	
United Scientific Holdings plc, Avimo Ltd	
TL10-T articulated telescope laser rangefinder 466	
United Scientific Instruments Ltd	
Gun control equipment for T-series MBTs	
United States Army Tank Automotive Command	
Advanced track for heavy weight class vehicles 277	

Advanced smoke launcher system

2	
ZF Friedrichshafen AG	
automatic transmissions, other	237
LSG 1000 transmissions	
LSG 2000 transmissions	236
LSG 3000 transmissions	235
Zaklady Mecaniczne PZL-WOLA	
Diesel engines	240

Yugoslav (Serbian/Montenegran) State Factories

AT-3 Sagger